Mekelle University

College of Business and Economics

Department of Management

Factors Affecting Adoption of Improved Cookstoves in Rural Areas: Evidence from 'Mirt' Injera Baking Stove (The Survey of Dembecha Woreda, Amhara Regional State, Ethiopia)

By: Tigabu Alamir

A Thesis Submitted to the Department of Management in Partial Fulfillment of the Requirements for the Award of Master of Arts Degree in Development Studies (Specialization in Regional and Local Development Studies)

Principal Advisor — **Girma Tegene (Assistant Professor)**

Co-Advisor — **Abdulkerim Ahmed (MA)**

June 2014

Mekelle, Ethiopia

Mekelle University
College of Business and Economics
Department of Management

Factors Affecting Adoption of Improved Cookstoves in Rural Areas: Evidence from 'Mirt' Injera Baking Stove (The Survey of Dembecha Woreda, Amhara Regional State, Ethiopia)

By: Tigabu Alamir

Approved by: Signature

1. _____ _____
(Chairman)

2. _____ _____
(Advisor)

3 _____ _____
(Internal Examiner)

4. _____ _____
(External Examiner)

Declaration

I, **Tigabu Alamir**, hereby declare that the thesis entitled "**Factors Affecting Adoption of Improved Cookstoves in Rural Areas: Evidence from 'Mirt' Injera Baking Stove (The Survey of Dembecha Woreda, Amhara Regional State, Ethiopia**)", submitted by me for the award of the Degree of Master of Development Studies is my original work and it has not been presented for the award of any other Degree, Diploma, Fellowship or other similar titles to any other university or institution.

Tigabu Alamir

Signature……

Mekelle University

Date ……

College of Business and Economics

Department of Management

Tigray, Ethiopia

Certification

This is to certify that this thesis entitled "**Factors Affecting Adoption of Improved Cookstoves in Rural Areas: Evidence from 'Mirt' Injera Baking Stove (The Survey of Dembecha Woreda, Amhara Regional State, Ethiopia**)" submitted in partial fulfilment of the requirements for the award of the degree of Master of Development Studies to the College of Business and Economics, Mekelle University, through the Department of Management, done by **Mr. Tigabu Alamir, ID No. CBE/PR: 080/05** is an authentic work carried out by him under our guidance. The matter embodied in this thesis has not been submitted earlier for award of any degree or diploma to the best of our knowledge and belief.

Principal Advisor:	**Co-advisor:**
Girma Tegene	Abdulkerim Ahmed
(Assistant Professor)	(MA)
Mekelle University	Mekelle University
College of Business and Economics	College of Business and Economics
Department Of Management	Department of Management
Tigray, Ethiopia	Tigray, Ethiopia
Signature ……	Signature ……..
Date ……	Date …..…….. …..

Acknowledgment

First of all, I would like to express my heartfelt gratitude to my principal advisor Girma Tegene (Assistant Professor) for his genuine and constructive comments from the early conception to the end of this research. In addition, I would also like to express my heartfelt gratitude to my co-advisor Abdulkerim Ahmed (MA) for his invaluable comments and unreserved assistance for the accomplishment of this research.

Second, special thanks to Adugnaw Wasihun (lecturer), Asnake Worku (lecturer), and Tsegazab Gebremariam (Msc student, economics department), Mekelle University, for their genuine comments and relentless assistance during specifying, analyzing and interpreting the econometric part of the research. My heartfelt thank goes to W/t Genet Aberaha for her cooperation in supplying me the necessary documents and other facilities during proposal development and data collection. My special gratitude goes to Ato Tesfaye Mengie, Ato Gashaw Bogale and Ato Beyene Alamir for their assistance in collecting data for the study.

Finally, I am indebted to my father Ato Alamir Tegegne and my mother W/o Muluken Alehegn for their relentless support and encouragement this work to be accomplished. I am also grateful to my brothers and sisters for their unreserved moral, material and financial support. Special thanks to my best friends Simachew Amare (Jigjiga University) and Abraham Abebe (Hawassa University) for their unreserved moral supports and idea sharing.

List of Abbreviations and Acronyms

CEINFMP	Cooking Efficiency Improvement and New Fuels Marketing Project
CRGE	Climate Resilient Green Economy
CSA	Central Statistical Agency of Ethiopia
ECO	Energy Coordination Office
e.g	for example
EnDev	Energising Development
EREDP	Ethiopian Energy Studies and Research Center
ESMAP	Energy Sector Management Assistance Programme
GACC	Global Alliance for Clean Cookstoves
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GTZ	German Agency for Technical Co-operation
HH	Household
HHE/PNR	Household Energy/ Protection of Natural Resource
ICs	Improved Cookstoves
IEA	International Energy Agency
MDGs	Millennium Development Goals
MoARD	Ministry of Agriculture and Rural Development
MoWE	Ministry of Water and Energy
NCCSPE	Ethiopia National Clean Cook Stoves Programme
WHO	World Health Organization

Glossary

Adoption: In this study adoption refers to the decision of households to acquire/adopt an improved cookstove and the interest to use.

Household: Here household refers to a group of people who eat together regularly and/or who sleep under the same roof together.

Improved Cookstove: An improved cookstove is a stove that is more fuel efficient and releases fewer emissions as compared to a traditional "three-stone" fire.

Kebele: Kebele refers to the lowest level government administrative structure in Ethiopia.

Inefficient: Here inefficient refers to using cooking devices with high biomass consumption, low per-unit energy production and increased emissions of smoke and particulates.

Injera: Injera is the traditional food in major Ethiopian households, and mostly prepared from "teff".

Open-fire: Open-fire refers to traditional method that relies on a clay 'U' or three stones to support cooking that are highly inefficient in their use of fuel.

Solid fuels: Solid fuels refer to fuels which include biomass fuels (such as wood, crop residues, dung, charcoal) and coal.

Woreda: Woreda refers to government's administrative unit in Ethiopia which is equivalent to district.

Abstract

In the developing world plenty of programmes and initiatives have been working to disseminate improved wood burning cookstoves which have health, economic and environmental benefits. To this end, understanding factors affecting adoption of improved cookstoves plays a key role. The purpose of this study was to identify factors that affect households 'Mirt' stove adoption decision in rural kebeles of Dembecha Woreda, Amhara Regional State of Ethiopia, by using mixed research methods. A survey was conducted with a structured questionnaire for 210 households that were systematically selected from three rural kebeles which were selected purposively. Semi-structure interviews and focus group discussions were also held with a total of 9 key informants. Data from questionnaires were analyzed by using descriptive statistics and binary logistic regression and data from interviews and the focus group discussions were analyzed through intensive textual analysis. The regression result reveals that women literacy level and separate kitchen house were found to be significant and positively correlated with the probability of Mirt stove adoption decision while marital status, source of wood and price of Mirt stove were found to be significant and negatively correlated with the probability of Mirt stove adoption decision. Furthermore, age and family size of the household characteristics were not found to be statistically significant. Providing services and supports to the potential users and producers, denying access to open forest and decentralizing Mirt stove production sites were found to be institutional factors to influence Mirt stove adoption. Membership in social associations, active participation in social activities, informal information exchange, early adopters and neighbors' influence were found to be social factors that influence Mirt stove adoption. Thus, women's literacy level should be increased through adult education. Improved cookstoves programs and projects should target on areas where there is no open forest access. And there should be more structural decentralization in terms of assigning rural energy experts from Woreda to kebele level.

Key words*: Adoption, Cookstoves, Logit Model, Improved, Open-fire, Solid-fuel*

Table of Content

List of Tables

Title **Page**

List of Figures

Title **Page**

List of Appendices

Title **Page**

CHAPETR ONE

INTRODUCTION

This chapter deals with the back ground of the study, statement of the problem, questions and objectives of the study. Besides, the scope and limitation of study, the significance of the study and the organization of the paper are also presented.

1.1 Background of Study

Worldwide about half of the population energy consumption is dependent on traditional fuel sources including wood, charcoal, coal and crop straws and leaves, and animal dung as well with traditional and inefficient stove technologies (Klasen et al, 2013). Cooking with stoves which are not efficient is associated with health problem, degradation of forest coverage as well as climate change (Lee et al, 2013). Indoor air pollution due to high level of smoke, deforestation due to inefficient fuel consumption, climate change like global warming due to incomplete combustion and loss of productive opportunities for collecting fuel wood are partly attributed to the use of traditional (three stone) cooking practice (Puzzolo, 2013). According to International Energy Agency (IEA, 2010), globally it is estimated that about 1.5 million each year and 4000 each day pre mature deaths are associated with the indoor air pollution from the use of biomass in inefficient cookstoves in 2030, which is more deaths than malaria, almost as equivalent as tuberculosis and almost half as many as HIV/AIDS.

Energy supply in developing countries is primarily dependent upon traditional sources including wood, charcoal, agricultural residuals and animal wastes (IEA, 2010). About fifty-six percent of the population in developing countries depends on traditional biomass and coal and cook with open three-stone fire which is associated with high level of indoor air pollution; to which 38 percent of annual deaths is attributed (WHO, 2009). According to International Energy Agency (2010), in developing countries about 2.7 billion people burn biomass and it is estimated this number to, if new measures like clean biomass cookstove technologies dissemination and adoption are taken, increase to 2.8 billion by 2030.

Energy supply in African countries is heavily dependent on traditional fuels like wood, agricultural residues, animal waste, charcoal and coal which accounts above 80% (GACC, 2011). To the extreme, in some African countries solid fuel accounts above 95% total energy supply and largely burn with open three stone fire inefficiently which also results in negative effect on health and the environment (Karekezi et al, 2002).

The Sub- Saharan African countries energy supply is heavily dominated by biomass which accounts above 90%, and the dominant cooking practice is three-stone open fire (Adkins et al, 2010; Schlag & Zuzarte, 2008). According to estimation by International Energy Agency (2010), the number of people relying on traditional biomass in sub-Saharan Africa is projected to increase from 585 in 2009 into 652 million in 2030 which accounts for 54 % of the world total as compared with 41 % in 2009.

Like many other sub-Saharan countries, Ethiopia's energy supply is heavily dependent on solid fuel that accounts for above 95 % (NCCSPE, 2011). This heavy dependence and inefficient utilization of biomass resources is partly attributed to the depletion of the country's forest resources (Gebreegziabher et al, 2010; Asres, 2002; Shanko, 2001) and 4.9% of the Ethiopian burden of disease (Damte & Koch, 2011).

In rural areas of the developing part of the world, since modern cooking fuels like electricity are both unavailable and unaffordable for many in the near future, the use of solid biomass for cooking is likely to continue. Therefore, efforts to develop, adopt and use improved biomass cook stoves is the best intermediate solution of improving the way biomass is supplied and used in addressing the adverse impacts of open-fire (GIZ, 2013; Barnes et al, 1994). Global Alliance for Clean Cookstoves (GACC, 2011, p.4) states the potential benefits of adopting improved cookstoves as follow;

> *Not only is adoption of clean cooking solutions a health, economic, gender, and environmental imperative, it is essential for achieving the United Nations Millennium Development Goals (MDGs) for child mortality, maternal health, poverty eradication, gender equality, and environmental sustainability.*

Improved biomass cookstoves have multiple economic, social, environmental, and health benefits (Jacob, 2013; Bwenge, 2011; Rwiza, 2009; Schlag & Zuzarte, 2008; Asres, 2002; Barnes et al., 1994 and others).

Since 1970s, many improved biomass cookstove programs have been set and promoted by governments, donors and Non-Governmental Organizations and other for and not for-profit organizations in the developing part of the world (Puzzolo et al, 2013; Gifford, 2010; Makame, 2007; Barnes, 1994). Given the expected household benefits, research to examine factors influencing improved cookstoves adoption decisions at the household level has become more urgent and deserves attention (Mobarak et al, 2012; Damte & Koch, 2011). Understanding the factors that influence a household's decision to adopt improved stoves is essential element for the realization of economic, social, environmental, and health benefits of improved cookstoves and for the success of intervention programs (Lamarre-Vincent, 2011).

However, the determinants of improved cookstoves adoption and sustained use have not been yet fully examined, thus, more rigorous research helps for strengthening the understanding of which factors are most important for securing adoption and sustained use (Klasen et al, 2013; Puzzolo, 2013; Damte & Koch, 2011). Lewis and Pattanayak (2012) also, in their systematic review, concluded that adoption study of improved cook stoves is scarce, scattered, and of differential quality. Besides, Puzzolo et al (2013) and Schlag and Zuzarte (2008), in their systematic review of factors affecting the adoption of improved cookstoves, concluded that important variables such as the role of socio-cultural and institutional factors are understudied and they recommend future researches to include these variables.

Therefore, this study may contribute to fill this gap by identifying factors affecting the adoption of improved cookstoves since these understudied variables (social and institutional factors) were included in the analysis.

1.2 Statement of the Problem

Above ninety-five percent of Ethiopia's national energy supply is heavily dependent on solid fuel (NCCSPE, 2011). The heavily dependency on biomass fuel, coupled with open three-

stone fire cooking, is one of the significant causes of deforestation and forest degradation, resulting in growing fuel scarcity and higher firewood prices, loss of agricultural productivity (MoWE, 2012; Dawit, 2011; Gebreegziabher et al, 2010). According to César and Ekbom (2013), between 2010 and 2030 annual fuel wood consumption will rise by 65% with large effects on forest degradation.

According to Ethiopia National Clean Cook Stoves Program (NCCSPE, 2011) more than 99% of the rural households depend up on firewood for cooking and heating purpose. The household sector dominates and continues to dominate, accounting for about 90 % of total energy consumption (NCCSPE, 2011; ESMAP, 1996). The preparation of the Ethiopian staple food named 'Injera' is the country's largest source of fuel use which accounts around 50% of the households fuel consumption and causes carbon emissions, environmental degradation and negative effects on women and children health; through (indoor) air pollution, firewood collection and burns from cook fires(Assefa, 2007; Wosenu, 2004).

To improve household energy efficiency in 'Injera' baking, the Ethiopian Energy Studies and Research Center (EREDPC) had developed the 'Mirt' Injera baking stove as one intervention and it is on the process of dissemination (MoWE, 2012; Megen power Lted, 2008; ESMAP, 1996). 'Mirt' stove has tremendous potential for reduction of fuel wood consumption, by up to 50 per cent compared to the traditional three stone open-fire, and can reduces dangers of burning and increases fuel efficiency (GIZ, 2012; Simons, 2012; Wosenu, 2004).

For the success of improved cookstoves disseminating initiatives, programs and projects and for the realization of the potential benefits of improved cookstoves, first stoves must be adopted and then sustainably used by households (GACC, 2012; Barnes et al, 1994). For this end, research understanding factors influencing the adoption and sustained use of improved cookstoves is crucial (Puzzolo, 2013; GACC, 2012; Mobarak et al, 2012; Barnes et al, 1994).

In study area there is a project (GIZ) which has been producing and disseminating Mirt Injera baking stove to users through its local stakeholders with close partnership of Dembecha Woreda agricultural office and kebele offices agents since 2008. In addition to the involvement of GIZ in the production and dissemination of 'Mirt' stove, the government of Ethiopia has been and also working to implement its national program, called Ethiopia

National Clean Cook Stoves Programme (NCCSPE), since 2011 through Woreda Water Office (Woreda Rural Energy) mainly 'Mirt' stove to the rural kebeles. There is also a new initiative called Ethiopia Improved Cookstoves Initiative (CPA 1) to disseminate Mirt stove for 21 years under the implementation of World Food Progamme-Ethiopia.

Unfortunately, studies about the determinant factors of Mirt Injera baking stove adoption are limited in Ethiopia. Biruk (2011) at Agarfa district in Oromia Regional State, Damte and Koch (2011) in Ethiopian urban areas, Gebreegziabher et al (2010) in Tigray and Dawit (2008) at Adea Woreda, Oromia Regional State, are the previous the studies conducted regarding factors influencing the adoption of 'Mirt' stove. To contribute in overcoming this limited empirical study in Ethiopia, Damte and Koch (2011) recommended further research to be conducted.

As far as the researcher's knowledge is concerned, there was no study conducted on factors affecting 'Mirt' Injera baking stove adoption in rural areas of Dembecha Woreda. Apart from this, all of the previous studies in Ethiopia did include only variables of household characteristics, the access to open forest, having separate kitchen house, and to some extent social influence in analyzing factors affecting Mirt stove adoption. All of the previous studies in Ethiopia did not include price and institutional factors in identifying factors affecting rural households Mirt stove adoption decision.

A key factor influencing the implementation, promotion as well as dissemination of improved cookstoves in a given country is its existing institutional infrastructure and set up (Makonese et al, 2006). Institutional factors such as awareness creation to potential users, regulation of the improved cookstoves' standard and price, financing options such as credit access and decentralizing production site are important variables that influence the households improved cookstoves adoption decision (GIZ, 2013; Puzzolo, 2013). The price of improved cookstoves is also considered as one important factor to influence the adoption decision. For instance, Axen (2012) argues that the price of improved stoves and households positive perception about the price affect the household's adoption decision. Damte and Koch (2011) also recommended that future studies should take in to consideration the effect of price on households' technology (Mirt stove) adoption decision.

As a result, this research differs from previous studies in Ethiopia in that it included institutional factors and the effect of price in the analysis of factors affecting the adoption of Mirt stove. Therefore, this study may add an original contribution to the existing fund of knowledge with regard to factors affecting households Mirt stove adoption decision.

1.3 Research Questions

The research was conducted to answer following questions:

1. What is the status of Mirt stove adoption in Dembecha Woreda rural kebeles?
2. Which household characteristics have effect on Mirt stove adoption decision?
3. What is the effect of fuel wood source on Mirt stove adoption decision?
4. What is the effect of price on a household's Mirt stove adoption decision?
5. How institutional factors influence a household's 'Mirt' stove adoption decision?
6. How social factors influence a household's 'Mirt' stove adoption decision?

1.4 Research Objectives

This study was conducted to achieve one general objective and six specific objectives. In this section, these objectives are clearly put.

1.4.1 General Objective:

The main purpose of this study is to investigate factors that affect households' adoption decision of 'Mirt' stove in rural kebeles of Dembecha Woreda.

1.4.2 Specific Objectives:

This study was conducted to achieve the following specific objectives:

1. To assess the status of Mirt stove adoption in Dembecha Woreda rural kebeles;
2. To identify the effect of household characteristics on Mirt stove adoption decision;
3. To investigate the effect of wood source on Mirt stove adoption decision;
4. To analyze the effect of price on a household's Mirt stove adoption decision;
5. To examine the influence of institutional factors on 'Mirt' stove adoption decision;
6. To examine the influence of social factors on 'Mirt' stove adoption decision

1.5 Scope and Limitation of the Study

Under this section, the geographical, conceptual, theoretical and methodological scopes of this study are presented. Besides, the limitation of this research is also dealt.

1.5.1 Scope of the Study

Geographically, this study was limited to Dembecha Woreda in rural areas (kebeles) in Amhara Regional State of Ethiopia. Conceptually, this research was limited to identifying factors affecting adoption of 'Mirt' stove at the household level. Theoretically, the research was based on the ideas of Energy Ladder, Energy Stacking and Diffusion of Innovation theories in identifying factors affecting households' decision to adopt or not. Besides, methodologically, this study employed mixed research methods and in terms of time, this research used cross-sectional data that was gathered in identifying factors influencing the adoption of Mirt stove.

1.5.2 Limitation of the Study

This research did not include the urban areas that are found in Dembecha Woreda. This study also was limited to only 'Mirt' stove. The study did not include other fuel efficient cookstoves. The research was limited to identify factors affecting the adoption of 'Mirt' stove at the household level; it was not about sustained use. This research faced limitations due to the very nature of strategies, methods and tools that were employed. Longitudinal data were not used for this study.

1.6 Significance of Study

The findings of the study may help project implementers, local 'Mirt' stove producers, Woreda water office, and Woreda agricultural office and kebele agents and National Clean Cookstoves Program of Ethiopia to be aware about the determinant factors which affect households Mirt stove adoption decision. Since the determinant factors that affect households 'Mirt' stove adoption decision were investigated, the above mentioned bodies can easily identify the potentially effective intervention areas which can play crucial role for their success. If the above mentioned bodies take in to consideration factors influencing

household's adoption of 'Mirt' stove and work to overcome barriers of adoption, then households would likely to adopt the stove. As a result, all the households and the projects would be beneficiaries, and at large this contributes its part for the realization of Ethiopia's Green Economy Strategy.

Other researchers may also use the findings of this study in relation to factors affecting the adoption of 'Mirt' stove in rural areas. The study may contribute to the contemporary empirical literature on factors that determine household choice of adoption of improved cookstoves in developing countries.

1.7 Organization of the Study

This thesis has five chapters. The first chapter deals with the background of the study and defines the problem of the study, basic questions and objectives of the study, the scope and limitation of study and the significance of the study. The second chapter includes improved cookstoves programmes, the development of improved cookstoves and projects in Ethiopia, best experiences, the benefits of adoption of improved cookstoves, empirical studies on factors affecting the adoption of improved cookstoves and determinants of improved cookstoves adoption. In addition, this chapter discusses the theoretical and conceptual framework of the study. The third chapter deals with the methods of the study. Under this section, the selection and study area description, data type and source, research design and research strategy, sampling design and procedures, data collection and instruments, data collection procedure, and data processing, definition and description of variables as well as model specification are dealt. The fourth chapter presents analysis and discussion and the fifth chapter of this paper deals with conclusion and recommendation. Finally, the reference materials and appendices are also included.

CHAPTER TWO

LITERATURE REVIEW

This chapter includes concepts and operational definitions of terms. The development of improved cookstoves programs, the development of improved cookstoves and projects in Ethiopia, best experiences, the benefits of adopting improved cookstoves, empirical literature on factors affecting the adoption of improved cookstoves and determinants of improved cookstoves adoption are also included under this section. In addition, this chapter discusses the theoretical base and conceptual framework of the study.

2.1 Improved Cookstoves Programmes

Even though the development and the adoption of wood-burning stoves traces back, as an intervention program it was following the 1970s oil price rise. Later on, the desire to rationalize the continuing reliance on biomass resource, the desire to mitigate deforestation and to narrow down the gap between fuel supply and demand improved cookstoves programs have given high focus on energy efficiency (Inayat et al, 2012; GACC, 2011; Barnes, 1994). To address higher oil prices, increasing deforestation, and fuel wood crisis governments, donors and nongovernmental organizations (NGOs) came up with supply-side and demand-side strategies and started to finance and develop stove programs. The development and dissemination of improved stoves is one demand-side intermediate solution in developing countries where clean fuels like electricity are not available or will not be affordable in the near future(Inyant et al, 2012; GACC, 2011; Barnes, 1994).

Since 1970s, many improved biomass cookstove programs have been set and promoted by governments, donors and Non-Governmental Organizations and other for and not for-profit organizations in the developing part of the world (Puzzolo et al, 2013; Gifford, 2010; Makame, 2007; Barnes, 1994). Some of national improved cookstoves programs were established and are on implementation including programs in Guatemala, India, Indonesia, Kenya, Nepal, Papua-New Guinea, Senegal, Somalia, Sri Lanka (Gifford, 2010), Ethiopia (NCCSPE, 2011).

In the present days many regional and global programs and initiatives also have been initiated and are being implemented by GIZ, the Economic Community of West African States (ECOWAS), the East African Community(EAC), the United Nations Commission on Sustainable Development(UNCSD), the United Nation Secretary General's Advisory Group on Energy and Climate Change (AGECC), International Energy Agency (IEA) and the UN Foundation Global Alliance for Clean Cookstoves (UNGACC)(Puzzolo et al, 2013).

According to the report by Global Alliance for Clean Cookstoves (GACC, 2012), Africa as a region has the largest number of stoves manufactured (4.8 million), 78% of which was in Ethiopia and Kenya, while Asia manufactured about 4.3 million stoves with the lion share of China. China, Ethiopia, Kenya, Cambodia and Bangladesh were reported as the largest improved cookstoves manufacturing countries by the year 2012.

2.2 Improved Cookstoves Development and Projects in Ethiopia

Ethiopia's energy supply is heavily dependent on biomass, which accounts for above 95% and in terms of sectoral consumption, household accounts for about 91.3% of the total energy consumption, of which biomass fuel accounts 98.5 % and also within the household sector the rural and urban household energy consumption accounts for 92 and 8% respectively (Asres, 2002). This heavy dependency on biomass fuel, coupled with open three-stone fire cooking, is one of the significant causes of deforestation and forest degradation, resulting in growing fuel scarcity and higher firewood prices, loss of agricultural productivity, creates indoor air pollution (MoWE, 2012; Gebreegziabher et al, 2010). According to César and Ekbom (2013), between 2010 and 2030 annual fuel wood consumption will rise by 65% with large effects on forest degradation. Thus, for developing countries like Ethiopia whose energy supply is heavily dependent on biomass fuels such as wood, charcoal and agricultural residues, technical advances in energy efficiency are critical (NCCSPE, 2011; GACC, 2011).

By taking in to consideration the consequences of excessive and inefficient use, the Ethiopian government and other oversea organizations (mainly GIZ) have embarked on a two-pronged policy tree planting or afforestation and dissemination of more efficient stove technologies (Gebreegziabher et al, 2006). In the case of energy efficiency, mainly the Ethiopian Energy Studies and Research Center (EESRC), currently, Ethiopian Rural Energy Development and

Promotion Center, exerted immense efforts since 1989 to develop improved stoves and three types of improved stoves have been developed, Lakech charcoal stove, Electric Injera stove and Mirt improved biomass Injera stove (Asefa, 2007; Gebreegziabher et al, 2006).

The National Clean Cook Stove Program Ethiopia (NCCSPE) is also one of the efforts for this purpose and improved cookstoves play a great role in reducing deforestation due to their fuel wood saving feature; reduce GHG emission due to less smoke, reduce indoor air pollution and have other social and economic benefits (NCCSPE, 2011).

Under the implementation of World Food Progamme-Ethiopia, there is also a new initiative which is called Ethiopia Improved Cookstoves Initiative (CPA 1) to disseminate Mirt stove for injera baking that lasts for 21 years (WFP-Ethiopia, 2013).

2.2.1 General Description of 'Mirt' Stove

Mirt Injera baking stove was first developed in the first half of the 1990s by the Ethiopian Energy Studies and Research Center (EESRC), under a project called World Bank funded Cooking Efficiency Improvement and New Fuels Marketing Project (CEINFMP) (Assefa, 2007; Dawit, 2008). Mirt stove is used for baking Injera and it is produced with mortar- a mixture of scoria (red ash) or pumice or river sand with cement (Simon, 2012). GIZ-HERA (2012, p.2) describes Mirt as follow:

> *Mirt stove has six parts that are joined together. Four parts fit to make a cylindrically shaped enclosure (about 66cm in diameter and 24cm high) where the firewood is burned under a baking plate. Two other parts joined one atop the other and are fitted with the cylindrical enclosure from behind. These last two parts regulate the flow of smoke in the stove and provide a rest for the cooking pot. The cylindrical enclosure has two openings. The first opening, which has a semi-elliptic shape, is at the lower front of the enclosure and is about 24cm wide and 11cm high. It is used as fuel and air inlet. The second is at the rear up, where the enclosure is fitted with the smoke regulating parts, as smoke outlet. This opening is of rectangular cross section and has a dimension of 19cm width and 7cm height.*

Picture 1: Mirt stove

Source: Adapted from GIZ-HERA (2012)

Depending on the thickness of the parts as well as the raw materials used, the total weight of Mirt ranges 45kg - 65kg.

2.3 Benefits of Adopting Improved Cookstoves

As it was stated in the background of this paper, cooking and heating with solid fuels on open fires have adverse impact on health, especially women and children, households' economy, environment and on global climate change too (GIZ, 2013; GACC, 2011; WHO, 2009; Duflo et al, 2007; Rehfuess, 2003). Improved cookstove program and project implementers and coordinators including national programs, regional and global initiatives, donors, non-governmental organizations and other stakeholders throughout the developing world strongly claim the significant role of improved cookstoves in improving households health conditions, improving the livelihood of the poor, reduce the rate of deforestation and mitigating global climate change (GIZ, 2013; GACC, 2011; WHO, 2009). Global Alliance for Clean Cookstoves (GACC, 2011) and others argue that in addition to its contribution to health, economic, gender, environmental imperatives, the adoption of improved cookstoves plays crucial roles United Nation Millennium Development Goals(MDGs), specifically child mortality, maternal health, gender equality, poverty eradication and environmental sustainability, to be achieved. Biomass Program in its Biomass Cookstoves Technical

Meeting Summery Report (2011) argues for the positive role that improved cookstoves play such as reducing cooking related health problems, saving fuel wood and time to collect fuel wood, reducing the rate of deforestation and mitigating global climate change.

These claims on potential benefits of adopting improved cookstoves have been and are supported by many empirical case studies and experiments in developing part of the world. Case studies in developing regions such as Asia, Africa, and Latin America asserted the positive impact of adopting improved cookstoves on health, economy, the environment and others.

Asia: In China Dewan et al (2013) found that the adoption of improved cookstoves can reduce fuel wood for cooking, time to collect fuel wood, and the newly felled trees by 40.1 %, 38.2 % and 23.7% respectively. Ewards et al (2004) also found that in China ICS have both short-term and long term impacts. In the short run ICS reduces the emission of health risky pollutants and in the long term, these stoves play significant role in reducing greenhouse gases emission and mitigate global warming. Boy et al (2000) found that in Guatemala a wood-burning improved stove, called Plancha (the modified), can save wood by about 39%, thus, saves time spent for wood collection and reduces the level of indoor air pollution. They argue that these roles of improved cookstoves have important implication for the interrelated aspects of development like health promotion, protection of the environment and the households' economy.

South America: A study by Garcia-Frapolli et al (2010) in Mexico also revealed that the adoption improved biomass cookstove, patsari, has a significant contribution for the improvement of living condition mainly because of wood savings (about 53%) and reduction indoor air pollution related health problems(by about 28%). Romieu et al (2009) investigated that patsari wood-burning stove in Mexico has positive impact on improving and reducing women's respiratory system and provides other cofounded benefits such as eye comfort. Armendariz et al (2008) also asserted that improved coostoves in Mexico can reduce particulate matter and Carbon monoxide (CO) concentrations by 74 % and 78% respectively. They found also improved wood-burning stoves reduce personal exposure, for example Carbon monoxide (CO) personal exposure can be reduced by up to 78%. Berrueta et

al (2008) revealed that patsari wood-burning stove in Mexico can save wood ranging from 44-65%.

Africa: A study in Gambia by Jacob (2013) also found that improved wood-burning stoves can save fuelwood consumption up to 40% and reduce indoor air pollution up to 90%. A study by Bwenge (2011) in Tanzania also came with evidence that in Tanzania the adoption of ICSs saved fuelwood consumption by about 70%; reduced women's workload, reduced the time spent to collect food from 4 hrs to 2 hrs per day; created self-employment and source of income for the producers; and reduces smoke emission. In Eritrea Ergereman (2003), also, found that the adoption of improved biomass stoves reduces indoor air pollution, reduce concentration of smoke, fuel saving, money and time saving for acquiring fuel and less pressure on forest and energy resources, reduces greenhouse gases, skill development and job creation in the community.

Ethiopia: Assefa (2007) experimentally found that in Ethiopia improved cookstoves, particularly Mirt stove can reduce carbon monoxide (CO) concentration and particulate materials by about 88% and 17 % respectively. A study by Gebreeziabher et al (2006) in Ethiopia found that assuming an average of 79 t of biomass per ha, the potential reduction in deforestation amounts 1,794 ha per year. They also argue improved stoves are able to reduce land gradation in such a way that if the stoves are adopted (1) less dung will be used as fuel so more manure is available, thus, fertile soil; (2) less wood consumption, thus reducing deforestation so more wood is available, in turn less dung and crop residues for fuel and; (3) less time spent for fuel wood and dung, thus, less time spent for cooking.

In Ethiopia Asres (2002) found that the adoption of improved cookstoves (Lakech and Mirt stoves), can save about 475.44 kt wood, about USD 47million and 122, 619 ha of forest per annum; reduce indoor air pollution and improve health conditions as well as mitigate greenhouse gases emission. The study also asserted that Mirt stove saves fuel wood by about 45% as compared to open- fires.

2.4 Best Experiences: China and Kenya

Since 1970s, many improved biomass cookstove programs have been set and promoted by governments, donors and Non-Governmental Organizations in the developing part of the world, but the failure overwhelmingly large comparing to the success story (Puzzolo et al, 2013; Gifford, 2010; Barnes, 1994). However, there have been some notable success stories, which provide ample evidence and useful experience for other programs (Teodoro, 2008). According to the work of Barnes et al (1994), community involvement in stove development and design, local manufacture and markets development and cost affordability and financial schemes were found to be the main reasons for the success of improved cookstoves projects and programs.

China: The most successful stoves programme has been China's National Improved Stove Program (NISP) which was initiated in the early 1980s (Gifford, 2010; Smith & Deng, 2010). By 1992, more than 60% of rural households adopted improved stoves (Climate Institute, 2009). According to the report by Global Alliance for Clean Cookstoves (GACC, 2012), China takes the lion share of Asia's improved cookstoves manufacturing by the 2012.

The success in China has been attributed to stove designs suited to users' needs, targeted national promotion schemes and effective local implementation (Teodoro, 2008), use of public education and training (Climate Institute, 2009). From this one can understand that for the success of programs and projects, understanding the needs of the people and the most technical, social and cultural requirements, taking into account the national programs scheme, involving the target community in the production and providing training and education to the producers and potential users are crucial concerns.

Kenya: The Kenya's national program, under auspice of Ministry of Agriculture, is one of success stories in Africa (Teodoro, 2008). According to Winrock International (2011), Kenya has a good success story in Africa as compared to other countries and at country level 30%-40% of households have an improved stove of some type and 50-60 % in urban areas. According to Teodoro (2008), the success in Kenya has been attributed to an important focus on the issues of market, replication, mass production, low cost, efficiency, technology

transfer, local production and commercialization as well as the stoves design was simple and small size.

2.5 Empirical Literature on Factors Affecting Cookstoves Adoption

Despite the potential benefits and the efforts of national, regional and global initiatives, programs and projects the rate of improved cookstoves adoption has fallen behind the expectation due to different factors (Puzzolo, 2013; Berkeley Air Monitoring Group, 2012; Lewis & Pattanayak, 2012; GACC, 2010; WHO, 2009; Barnes et al, 1994). To identify factors affecting the adoption of improved cookstoves studies have been conducted and the main findings are summarized.

Puzzolo et al (2013), in their systematic review of enablers and barriers to large-scale uptake of improved solid fuel stoves, by taking 57 case studies, found meeting users' needs, providing valued savings on fuel, meeting user expectations and ensure durability, higher socio-economic status, having kitchen house, knowledge on the relative benefits of ICs, having success with early adopters, insuring support to users in initial use, developing an efficient and reliable network of suppliers/retailers, providing financial access were among significant factors that influence the adoption of improved cookstoves. With regard to household head gender, age, family size studies have come up with different results. Another study by Dewan et al (2013), examined how social marketing tools increase fuel-efficient stove adoption in China by taking in to account knowledge, attitude and interpersonal communication. The study found that the knowledge about the relative benefits of fuel efficient stoves and the disadvantages open fire, attitudinal change to use and realize the potential benefits of fuel efficient stoves and interpersonal communication are positive significant factors of fuel efficient stoves adoption. Pre and post campaign result showed significant improved cookstoves adoption percentage increment due to the increment of knowledge, attitudes, and interpersonal communication. Post-campaign (within 1 year) 28.0% and 43.1% of those surveyed within 1 year of and 2.5 years adopted the technology.

Lewis and Pattanayak (2012) conducted a review of 11 empirical studies with regard to factors affecting improved cookstoves adoption. Based on the review, household head education, income, household size, fuel-wood price and access to credit were found to be

statistically significant positive factors that determine the adoption of improved cookstoves. On the other hand, significant negative associations were found between the adoption of improved cookstoves and household head's age and socially marginalized status. A filed assessment of improved cookstoves adoption practices in Indonesia was conducted by Geary et al (2012). The assessment investigated that awareness of dangers of indoor air pollution, knowledge about and the availability of improved cookstoves, the built environment to install and the increase price of wood fuel as well as social networks are factors that positively affect improved cookstoves adoption decision. On the other hand, the free availability of fuel-wood was found to be one of the factors that lead to the decision not to adopt improved cookstoves.

Menon and Thandapani (2011) conducted a study to understand the adoption dynamics of improved cookstoves among people living in rural India by including variables of motivation, affordability and level of engagement in their analysis. Neighbors influence, awareness campaigns, the effect of perceived risks/benefits of improve cookstoves vis- a-vis traditional stoves, income, education and stove design were found to be enabling factors for adoption decision. The study revealed that respondents who were recommended by their neighbors had founded to be adopters of improved cookstoves. The consumers education about the different financial instruments they can avail to purchase the cook stove so that the perceived expensiveness can be minimized.

Pine et al (2011) studied adoption and use of improved biomass stoves in rural Mexico by taking community's acceptance, household characteristics and season of adoption as explanatory variables. The study found that community acceptance of the stove, problematic experience with the traditional stoves and the compatibility of the stove with the type of fuel-wood used are statistically significant and positive factors of adoption of improved biomass stoves. From household characteristics, the presence of adult in the household, large household size, household head's occupation (farmer) and household income and non-rainy season were found to be positive and statistically significant factors in determining the adoption of improved biomass stoves. On the other hand, rainy season, households higher valuing of open fire over the improved ones, proximity and free forest access to collect wood were found negative factors of improved biomass stoves adoption.

Inayat (2011) also conducted a study to investigate factors that make people adopt improved cookstoves in rural Northern Pakistan by taking into account household characteristics and source of fuel-wood. The study found household head's level of education (proxy for awareness), income, household working members and source of fuel-wood to be determinant factors of improved cookstoves adoption decision. Households not collecting wood for free were found more likely to adopt improved cookstoves in rural Pakistan. On the other hand, total household head's age, household size, landholding and open fire hazards knowledge were found statistically insignificant factors in determining improved cookstoves adoption.

Adrianzen (2009) analyzed the concerns of village technology adoption pattern and village social capital and household characteristics to identify factors affecting improved cookstoves adoption decision in Northern Peruvian Andes. The study investigated that the higher success village adoption pattern, with stronger social capital, has a significant positive effect on a household's improved cookstoves adoption decision. From household characteristics, the household's head gender and level of education, the household's number of adults, presence of a female adult member in the household, the household's wealth and the household's participation in women and environmental clubs were found statistically significant factors to influence a household's decision of improved cookstoves adoption. Slaski and Thurber (2009) identified inherent motivation, affordability by the and compatibility/low required users engagement positive determinant factors of adoption while low motivation, low affordability and high required users engagement important obstacles of cookstoves adoption by the poor.

Troncoso et al (2007) analyzed socio-economic, cultural and environmental factors that affect improved cookstoves adoption in Rural Mexico. While the socio-economic level, cultural acceptability and lack of free access for open forest were found to be positively correlated with the adoption of ICs, there was no correlation found between improved cookstoves adoption and educational level, awareness about the relative benefits of the stove, household head age and payment of the stove. Agarwal (1983) identified household characteristics, stoves' technical, infrastructural and cultural aspects that affect improved cookstoves adoption. Households' socio economic status, the relative benefits of stoves, extension (e.g. awareness creation) and access to credit, rational and dynamic nature of a

community were identified as positive factors that affect the adoption of improved wood-burning stoves.

Africa

A recent study by Levine et al (2013) identified factors that impede the adoption of improved cookstoves in Uganda by considering variables of information, liquidity and present bias/term of payment. From the study it was found that customers' liquidity constraint, imperfect information, lack of confidence on the new stove's fuel saving performance and skepticism about the durability of the stove are important barriers of improved cookstoves adoption. The study examined the effect of a contract made for a free trial, time payments, and the right to return the stove in Kampala and Mbarara. The result showed that improved wood burning cookstoves adoption increased from 4 % to 46 % in Kampala and in Mbarara the adoption increased from 5 % to 57 %. In addition, the study found household size to be one significant factor in determining a household's improved cookstoves adoption decision.

Axen (2012) analyzed factors affecting the spread of fuel efficient cooking stoves in Northern Tanzania with the focuses of potential users' perception, financial capital, human capital, natural capital, physical capital, social capital and household head's gender. From the analysis, positive perception about the cookstoves and its price and access to credit, awareness and knowledge about the relative benefits of improved cookstoves, lack of access to wood for free and access to transport improved cookstoves and having separate kitchen were found to be enabling factors for the adoption and spread of improved cookstoves. Membership to social associations and be networked and the household head's positive interest were, also, found to be factors that positively affect the adoption and spread of improved cookstoves in Tanzania. On the other hand, the lack of these concerns and the free access of fuel-wood were found factors that hinder the adoption and spread of improved cookstoves.

Makame (2007) investigated the influence of individual factors, stove attributes and management support in Zanzibar. From individual factors'; information the benefits, income, and level of education, from stove attributes; trialability, observability, relative advantage, simplicity to use and compatibility and good program and project management and support

were found to be factors that positively influence improved cookstoves adoption. On the other hand, factors for failure to adopt were found to be poor quality of the improved cookstoves, the cost of stoves, poor information and education about the relative benefits of stoves. The study revealed that since the price of the improved cookstove (ranges US$2.5-US$5) more than the price of traditional charcoal stove (ranges US$1.5- US$5), households were found tending to purchase traditional charcoal stove.

Ethiopia

In Ethiopia Damte and Kohlin (2011) investigated the determinants of improved cookstoves (Lakech, Mirt stove and Electric Mitad) in urban areas by analyzing the variables of household characteristics, stove type and ownership, substitutability of stoves and separate kitchen and it features. With regard to Mirt stove, the household heads level of education, income, separate kitchen and household head's gender (female) were found to be positive significant determinant factors of adoption decision. Other variables of substitutability of the stove and the size of children in a household were found to be insignificant in relation to Mirt stove adoption. A study by Gebreegziabher et al (2010) identified factors affecting urban energy transition and technology adoption in Tigray, Northern Ethiopia, with the focuses of household characteristics and price variables. Household head's age, education, family size, and income/expenditure were indicated to be positive and significant factors to determine the adoption of new cooking appliance, electric 'Mitad' and improved wood-burning stoves while prices of fuel-wood, charcoal and kerosene were found to be insignificant in determining the adoption decision.

Another study in Ethiopia was conducted by Dawit (2008) to identify factors affecting rural and urban households 'Mirt' stove adoption decision 'Adea' Woreda, Oromia Regional State. From the analyzed variables of household characteristics, the stove's technical aspects and cost and financing, it was found that household income, household head's education and the stove's compatibility are positively and statistically significant factors in determining Mirt stove adoption decision in rural households. On the other hand, numbers of participants in fuel-wood collection and household head's age were found to be negative and statistically significant. Other variables such as family size, household head's gender, dwelling status,

separate kitchen and access to credit were found to be statistically insignificant to influence Mirt stove adoption decision in rural households. In contrary to the finding of Gebreegziabher et al (2010), household head's age was found to be negative and statistically significant determinant factor of Mirt stove adoption decision.

2.6 Determinant Factors of Improved Cookstoves Adoption

As it was reviewed in the previous section, there are factors that found to be determinant in determining households improved cookstoves adoption decision. These factors are discussed.

Age: The previous studies found contradictory results with regard to the correlation between age and improved cookstoves adoption. A review by Lewis and Pattanayak (2012), household head's age was indicated to be significant negative factor that determines the adoption of improved cookstoves across studies reviewed. In contrary, Gebreegziabher et al (2010) found household head's age to be positive and statistically significant determinant factor of Mirt stove adoption decision. The finding of Dawit (2008) reveals that household head's age is negatively and statistically significant determinant factor of Mirt stove adoption. With regard to the influence of a household head' age on household's improved cookstoves adoption decision, recent work of Puzzolo et al (2013) found inconsistency among research findings.

Therefore, based on the previous empirical works and with the assumption that older people may tend to be conservative in accepting new cooking technologies, in this study it is expected age to affect the household's Mirt stove adoption decision negatively.

Marital status: Single women (female headed households) were found more likely to adopt improved cookstoves as compared to married women male headed counter parts (Damte & Koch, 2011; Inayat, 2011; Adrianzen, 2009). The authors argue that in patriarchal society since husband more power to make economic decisions in the household, married women's improved cookstoves purchasing decision depends up on the willingness of their spouse. Having this understanding, thus, it is expected that marital status (in favor of single) to affect Mirt stove adoption decision positively in rural households.

Education: A review by Lewis and Pattanayak (2012) found that household head's education is positively and statistically significant factors that determine the adoption of improved cookstoves across studies reviewed. It is argued that educated potential customers are more likely to be aware of the benefits of improved cookstoves as compared to uneducated or less educated customers (Inayat, 2011; Menon &, Thandapani, 2011; Adrianzen, 2009). Menon and Thandapani (2011) again claim that the consumers education about the different financial instruments they can avail to purchase the cook stove so that the perceived expensiveness can be minimized. Damte and Koch, Gebreegziabher et al (2010), Dawit (2008) and Makame (2007) found household head's education as a positive factor in influencing Mirt stove adoption decision in Ethiopia. It was found positive association between the household head's level of education and Mirt stove adoption.

This previous literature about the effect of level of education on improved cookstoves adoption decision enables one to expect a positive effect of education on rural households' Mirt stove adoption decision in the study area. Thus, positive and significant correlation is expected between women's literacy level and Mirt stove adoption decision.

Income: The systematic review of Puzzolo et al (2013) found constituency among research results that higher socio-economic status is positive and significant factor in determining a household's improved cookstoves adoption decision. A review by Lewis and Pattanayak (2012) found that income is positively and significant factor that determine the adoption of improved cookstoves across studies reviewed. Pine et al (2011) and Inayat (2011) found that household income is determinant factor of households improved cookstoves adoption decision. The study investigated statistically significant positive correlation between improved cookstoves adoption and household income. The works of Damte and Koch (2011), Gebreegziabher et al (2010) and Dawit (2008) reveal that household income is statistically significant positive determinant factor in determining households' Mirt stove adoption decision.

Family size: With regard to family size, Puzzolo et al (2013) found inconsistency among findings. A review by Lewis and Pattanayak (2012) found that household size is statistically significant and positively associated with the probability of adoption of improved cookstoves

across studies reviewed. Pine et al (2011) found that household size is statistically significant factor that determines improved cookstoves adoption decision. The study revealed statistically positive correlation between improved cookstoves adoption and large family size. These authors claim that households with larger family size consume larger fuel wood as compared to households' smaller family size that results in influencing larger family size households to economize fuel wood usage. Gebreegziabher et al (2010) found that family size is positive and statistically factor in influencing adoption decision of Mirt stove. Households with large family size were found more likely to adopt improved cookstoves. Given this previous literature, it is expected that large family size positively affects households Mirt stove decision.

Separate kitchen: Puzzolo et al (2013) found constituency among research results that having separate kitchen is positive and statistically significant factor in determining a household's improved cookstoves adoption decision. Previous studies found separate kitchen house as one significant factor that has positive effect on a household's improved cookstoves adoption decision (Axen, 2012; Damte & Koch, 2011; Adrianzen, 2009). These works investigated the positive correlation between separate kitchen and improved cookstoves adoption.

Based on the existing literature, having separate kitchen is expected to have a positive effect on households' Mirt stove adoption decision in the study area. Households with kitchen are expected to be found more likely Mirt stove adopters with the assumption that since Mirt stove is larger in size and technically fixed in nature, additional space is needed.

Source of fuel-wood: Geary et al (2012) found that the free availability of fuel-wood one of the factors that lead to the decision not to adopt improved cookstoves. Source of fuel-wood is determinant factor of improved cookstoves adoption decision (Inayat, 2011). The investigation found that households not collecting wood for free were found more likely to adopt improved cookstoves. A study by Pine et al (2011) also found that the access to open forest is found to be negatively correlated and statistically significant with the probability of improved cookstoves adoption decision. Axen (2012) and Troncoso et al (2007) also

investigated a positive correlation between lack of access to open forest and improved cookstoves adoption and the vice versa.

Based on this empirical evidence, one can hypothesize that households that get fuel-wood with charge to be found more Mirt stove adopters as compared to households that obtain fuel-wood without charge in the study area. It is assumed that for households that get wood for free, fuel-wood saving or efficient use of wood may not be their concern while fuel saving the priority for those that buy wood.

Price: price variables include the price of improved cookstoves, the price of fuel-wood, the price of kerosene and others. But for this study purpose, the influence of improved cookstoves' price on households' adoption decision is reviewed. A recent study by Levine et al (2013) found that inability of the poor to pay the cost of improved cookstoves is one of important barriers of adoption decision. Axen (2012) argues that the price of improved stoves and households' perception on the price have effect on the probability of the households adoption decision. Slaski and Thurber (2009) identified that improved cookstoves' cost affordability by the poor is a positive determinant factor of adoption. The authors argue that low affordability of the cost improved cookstoves negatively affects cookstoves adoption likelihood by the poor. Makame (2007) found that the purchasing price of cookstoves is important factor in influencing a household's adoption decision. The study's result shows that since the price of the improved one (ranges US$2.5- US$5) more than the price of traditional charcoal stove (ranges US$1.5- US$3) households were found tending to purchase traditional charcoal stove.

These previous studies give a clue to expect what the effect of Mirt stove price to be on rural households' purchasing decision. Therefore, it is expected the price of Mirt stove to have a negative effect on the households' purchasing decision in the study area.

Other factors: From the empirical literature the other factors that are found to influence the adoption decision of improve cookstoves include institutional and social factors. Makonese et al (2006) maintain that the existing institutional set up is a key factor that influences the implementation, promotion and dissemination of improved cookstoves in a certain country. These authors found that training, technology and information exchange, technology standard

and decentralizing energy systems are institutional factors that influence the production, dissemination and adoption of improved cookstoves. The works of Puzzolo et al (2013) and Agarwal (1983) also found that extension services such as awareness creation and financial access to the users and the producer are positive institutional factors that influence the adoption decision of improved wood-burning stoves. Social factors are also found to be the other important variables to influence improved cookstoves adoption decision. For instance, Puzzolo et al (2013) and Adrianzen (2009) investigated that early adopters have a positive or negative effect on the others' likelihood of adoption. Menon and Thandapani (2011) also found that the influence of neighbors is one social factor to influence fuel efficient new cooking technologies adoption decision.

2.7 Theoretical and Conceptual Frameworks

Mixed methods researchers can use theory either deductively in testing and verification, or inductively as in an emerging theory or pattern (Creswell, 2003). Thus, this study was based on three theories; Energy Ladder Theory, Energy Stacking Theory and Diffusion of Innovation Theory.

With regard to household, there are two types of household energy choice theory, energy ladder and energy stacking (Iyant et al, 2011). Energy ladder model, considered as classic and traditional, places heavy emphasis on income (affordability) in both explaining and determining a household's energy/fuel/stove choice (Masera et al, 2000). This implies that the household's income is taken as the only determinant factor that influences households fuel/stove choice decision. But, this perspective is highly criticized by a number of studies with two practical reasons (Masera et al, 2000; Schlag & Zuzarte, 2008; Kowsari, 2013; Puzzolo, 2013). One of the criticisms is that there are multiple determinant factors, other than income, that influence households fuel/stove choice decision.

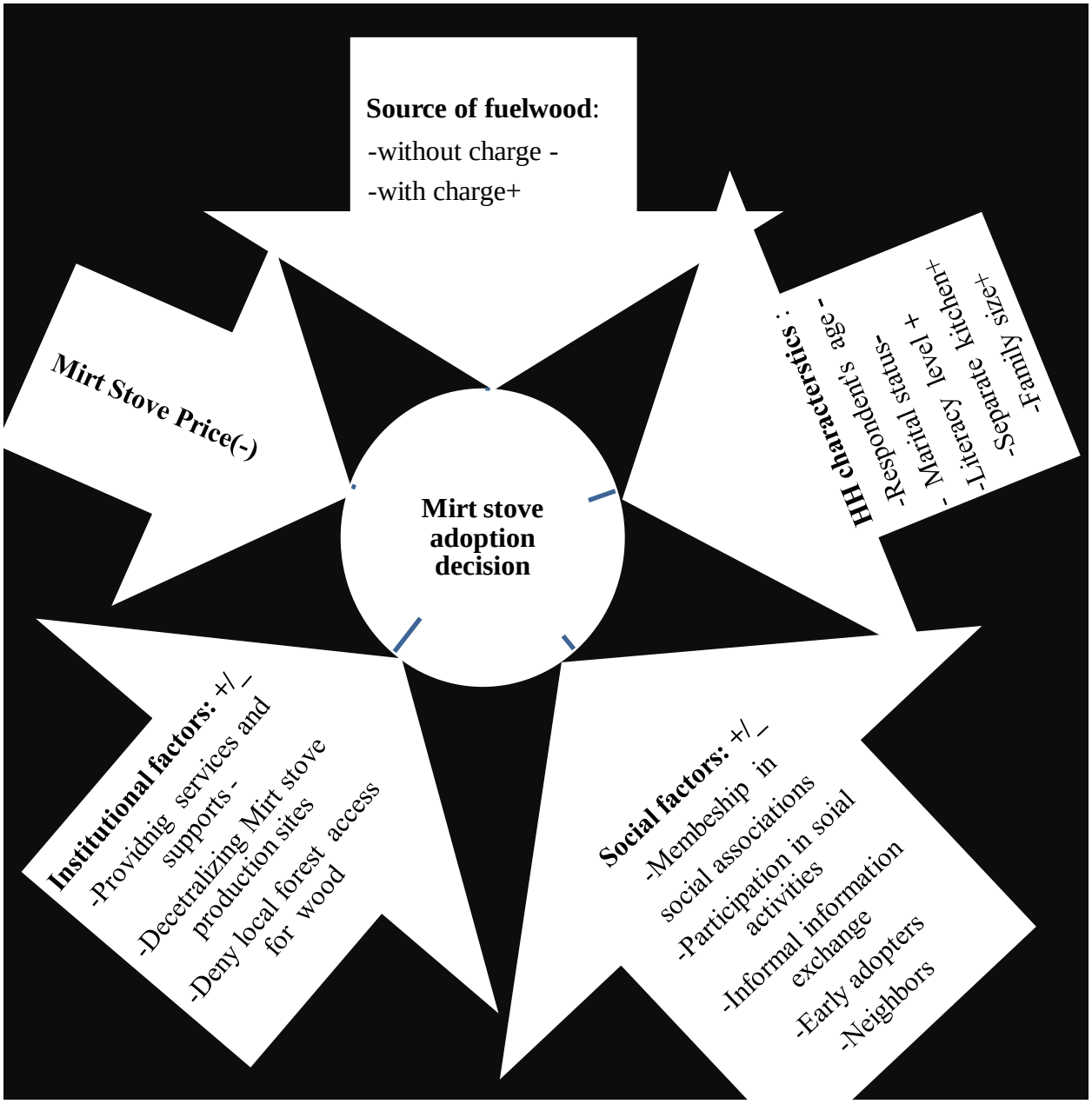
On the other hand, energy stacking household energy choice perspective overcomes the drawbacks of the energy ladder hypothesis. Energy stacking, also called fuel/stove stacking is considered as the latest and it is based on empirical evidence and is more realistic than the classic energy ladder hypothesis (Kowsari, 2013). Fuel type choice and/or stove adoption decision depends up on a complex interaction between economic, social, cultural and

environmental factors (Masera et al. 2000; Schlag & Zuzarte, 2008). Researchers (Mekonnen et al, 2009; Takama et al, 2011) also argue that income alone does not determine adoption/ stove choice; family size, age and education are significant and matter more in determining whether or not a household adopts. As a result, the recent studies applied energy staking hypothesis and recommend that future researches should not rely excessively on the energy ladder model; for households in poor developing countries, such as those in Ethiopia, more attention to be paid to other nonmonetary aspects besides income in the analysis (Mekonnen et al, 2009).

The other theory regarding technology adoption is 'Diffusion of Innovation theory'. According to Rogers (2003), the Diffusion of Innovation Theory asserts that individuals and early adopters in a certain social system are able to influence attitude and behavior of others informally either to promote or hinder the acceptance of a new technology. According to this theory, improved stove technologies are more likely to spread out in a certain population if the stoves first gain acceptance among 'early adopters.

Based on these stated theories, the literature that the researcher has reviewed and based on the findings of the previous empirical studies on factors affecting the adoption of improved cookstoves, the following conceptual framework was developed.

Figure 2.1: Conceptual Framework for Factoring Affecting Adoption of Mirt Stove



Source: Own construct (2014)

The positive (+) and the negative (-) signs indicate the expected influence of independent variables on the independent variable (the decision to adopt or not) based on empirical studies reviewed. The size differences among the variables' boxes do not have any message.

CHAPTER THREE

RESEARCH DESIGN AND METHODS

This part of the paper deals with the methods of the study. Under this section the selection and study area description, data type and source, research design and research strategy, sampling design and procedures, data collection and instruments, data collection procedure, data processing and analyzing procedures, definition and description of variables as well as model specification are presented.

3.1 Selection and Description of the Study Area

The study was conducted in Dembecha Woreda, which is located in West Gojjam zone in Amhara Regional State of Ethiopia. The majority of households (86.14 %) live in the rural part while 13.86% of households live in urban areas (CSA, 2007). The dominant ethnic group and language are Amhara and Amharic language which account 99.82% and 99.87 %, respectively (Mousley et al, 2013).

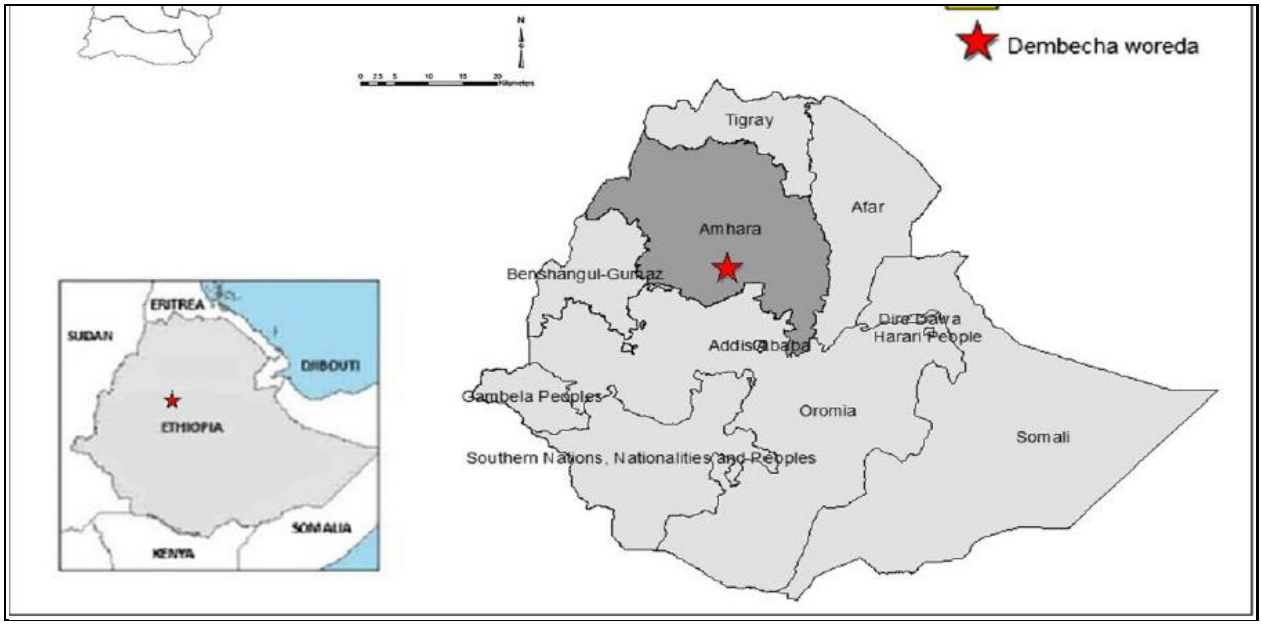
This Woreda has a total of 29 kebeles, 25 rural and 4 urban. The majority's livelihood is dependent up on agriculture (Dembecha Woreda Livelihood Report, 2007). The majority of people rely on traditional sources of energy and in the area energy efficient technologies, such as improved cookstoves, are also available in the area (Simon, 2012).

Deforestation is one of the pressing problems in Dembecha Woreda (Yared et al, 2010). The natural forest coverage in the Woreda is decreasing from time to time in alarming deforestation rate. According to Gete and Humi (2001), 7259.3 ha total natural forest was cleared between 1957 and 1995 in the Woreda with the rate of 27 % forest coverage in 1957 to 2 % coverage in 1982 and declined to 0.3 % natural forest coverage in 1995.

Angot-yedegera, Enewend and Lejet are among the rural kebeles in Dembecha Woreda which were selected to represent the remaining rural kebeles in the Woreda. These kebeles with a total of 4098 households, alike other rural kebeles, were not electrified while the study conducted. Angot-yedergera, which is one of the 25 rural kebeles in Dembecha Woreda, is

located 8km West of Dembecha town and far 5km from the nearest electrified town, Yechereka. The kebele has the total of 1463 households. At this kebele there is one 'Mirt' stove producer with the help and supervision of Woreda rural energy office. The other rural kebele in Dembecha Woreda is Enewend. This kebele is located 51km West of Dembecha town and far 34km from the nearest electrified town, Addis-alem. This kebele has a total of 1453 households. And at this kebele there are two 'Mirt' stove producers with the help and supervision of Woreda rural energy office. Lejet is also one of the rural kebeles in the Woreda with a total of 1182 households. This rural kebele is located surrounding Dembecha Woreda's main town, Dembecha town. In this locality there is one 'Mirt' stove producer to both the surrounding urban and rural dwellers with the help and supervision of GIZ-coordination office.

Figure 3.1: The Map of Dembecha Woreda



Source: Adapted from Mousley et al (2013)

While building a climate-resilient green economy, Ethiopia's vision is to achieve middle-income status by 2025 and to ensure sustainable development (CRGE, 2011). For this to happen, one of the priority areas identified by the Ethiopian government is efficient use of energy. To the specific to this study is to use biomass energy efficiently by using fuel efficient improved cookstoves. The National Clean Cook Stove Program Ethiopia (NCCSPE) is one of the efforts for this purpose. Improved cookstoves play a great role in reducing

deforestation due to their fuel wood saving feature; reduce GHG emission due to less smoke, reduce indoor air pollution and have other social and economic benefits. Reducing indoor air pollution will yield benefits for the poor, and help achieving the MDGs of reducing child mortality, and improve maternal health (WHO, 2009).

For the success of disseminating programmes and projects and to realize the potential benefits of improved cook stoves factors influencing the households' adoption decision are to be investigated (Puzzolo, 2013). In this Woreda (Dembecha) a GIZ has been implementing and going on the dissemination of Mirt stove in partnership with Woreda and kebele agricultural offices agents since 2008. Besides GIZ, Dembecha Woreda Water Office has been also disseminating Mirt stove by decentralizing the Mirt stove production sites at kebele level. But, to date factors affecting the adoption of improved cookstoves, particularly Mirt stove were not identified in this specific area. This was the reason that motivated the investigator to conduct this study in this specific area.

3.2 Research Design and Strategy

In this section, the design of the study such as the philosophical view to think through and the methods which were used are presented. The other concern of this part is that the research approach which was employed.

3.2.1 Research Design

Research design involves multiple issues such as the world view that the investigator thinks through, the strategies of the study and the methods to be used (Creswell, 2009). Therefore, this study followed the philosophy of pragmatism with reasons. According to the author, pragmatism is characterized as real-world practice oriented, pluralistic, and problem-centered and it applies in mixed methods research due to its advantages over other philosophical views such as positivism and constructivism in a sense that this philosophical world view provides the best understanding of a research problem, allows multiple methods to be used, different worldviews to think through, different forms of data collection and analysis.

The researcher employed descriptive survey research design. Descriptive method was used because the purpose of the researcher was to collect, analyze and conclude about the existing

conditions at a time. In addition, the researcher made a general conclusion about the whole population based on the data which were collected from only sample respondents. And also, the researcher found this method important as the required data were collected from samples of respondents and key informants. Besides, survey method enabled the researcher to effectively manage all the necessary activities that were taken place in the study. The researcher also used cross-sectional method, because the study was conducted in a manner that a small portion of a population was sampled only at a time.

3.2.2 Research Approach

Mixed research approach was employed. By mixed methods the weaknesses of the qualitative method would be tackled by the quantitative method and the weaknesses of the quantitative method would be overcome by the qualitative method; and thus, employing mixed methods strengths the study (Onwuegbuzie & Leech, 2004). Puzzolo et al (2013) recommend that studies designed specifically to strengthen the understanding of factors affecting improved cook stoves adoption and sustained use need to draw on a combination of quantitative and qualitative research strategies.

3.3 Data Type and Source

For this study, the researcher employed both quantitative and qualitative data with reasons. The quantitative data were employed in order to address research questions and objectives that could be better addressed quantitatively. The data about respondent's age, and family size and price of Mirt stove were gathered numerically (see definition of variables). The qualitative data were used to address research objectives which could be better addressed qualitatively. The data about the variables of the respondent's marital status and literacy level, source of fuel-wood, separate kitchen house, institutional and social factors were gathered qualitatively (see definition of variables).

With regard to the data sources, the researcher used both primary and secondary sources. The primary sources of this study were mothers of households and the key informants of local 'Mirt' producers, Woreda agricultural office, kebele agricultural offices (specifically natural resource management experts), and Woreda water office (specifically rural energy experts).

The secondary sources were the Woreda's water office 'Mirt' stove dissemination report through Woreda rural energy experts, and the kebeles' household frame.

3.4 Sampling Design and Procedures

To make generalization about the whole population different sampling designs and procedures are used to the get the truly representative sample (Israel, 1992). Thus, this section presents the sampling designs and procedures that were employed for this study.

The study selected three kebeles (Angot-yedegera, Enewend, and Lejet) from the total of 25 rural kebeles in Dembecha Woreda by using purposive sampling technique. Because it is in these rural kebeles Mirt stove has been introduced and disseminated when the research was being conducted. At large, there is homogeneity of household socio-economic characteristics, institutional set up and livelihood structures in all rural kebeles of Dembecha Woreda (Dembecha Woreda Livelihood Report, 2007). The more a homogeneous population, the smaller the sample size is found to be representative (Israel, 1992). Dawit (2008) also selected three rural kebeles from the total of 27 rural kebeles to investigate factors affecting the adoption of 'Mirt' stove in Adea district in Oromia Regional State of Ethiopia. Therefore, the findings of the study could potentially be generalized to all rural kebeles in the Woreda.

When the response for the attributes being measured is assumed a dichotomous, the use of yamane's (1967) tables and formulas to determine sample size is more appropriate (Israel, 1992). Since the dependent variable in this study was dichotomous, the researcher used Yamane's formula to determine the sample size for the questionnaire respondents, i. e;

$n = \frac{N}{1+N(e)^2}$, n=Sample size, N=total population, e= level of precision (0.065)

In the three selected rural kebeles, there were a total of 4098 households (Angot-yedegera = 1463 Enewend =1453, and Lejet = 1182). Therefore, the sample size (n):

$$n = \frac{N}{1+N(0.065)^2}$$

$$n = \frac{4098}{1+4098(0.065)^2}, \quad n= 223$$

To determine sample size in each kebele, the researcher employed proportional sampling technique, the total samples (223) to the selected kebeles proportionally. Each kebele sample size was computed as follow in table form.

Table 3.1: Proportional Sample Size Determination

Kebels	HHs no.	How to compute	Sample size
Angot-y.	1463	1463 x total sample / total HH=1463x223/ 4098	≈80
Enewend	1453	1453 x total sample / total HH=1453x223/ 4098	≈79
Lejet	1182	1182 x total sample / total HH=1182x223/ 4098	≈64
Total	4098	1463x223/ 4098 +1453x223/ 4098+ 1182x223/ 4098	223

Source: Own computation (2014)

Households for the structured questionnaire were selected by using systematic random sampling technique in each kebele from the households' frame. The reason behind using this sampling technique is its simplicity, fast and low costly (Zou, 2006). To overcome some flaws of this technique, the researcher did check up whether the households were systematically arranged or not, in each kebele frame. And the households were not arranged systematically. In the case of selecting the respondents of the questionnaire, the mothers were selected. This was in line with Damte and Koch (2011) who indicated that;

> *Women are the main expected beneficiaries of the Mirt stove, as in many cases they are the ones in charge of firewood collection, food preparation and usually spend a higher amount of time inside the dwelling place, benefiting significantly from reductions in indoor pollution.*

With regard to the semi-structure interviews and the focus group discussions, the key informants were drawn from the institutions working in the Woreda and respective kebeles and the "Mirt' stove producers by using purposive sampling method. A total of 9 individuals were interviewed and participated in the focus group discussions; 3 individuals (natural resource management experts) from the three selected kebeles agricultural offices, one person from the Woreda agricultural office, 2 persons from Woreda water office (the 2 rural energy experts) and 3 producers of Mirt stove from the selected kebeles (one from each kebele). While the two local producers were the close partners of the Woreda rural energy

under the Woreda water office, one local producer was the close partner of GIZ-ECO at Woreda level which has been producing and supplying Mirt stove to Dembecha town and the sounding rural kebele (Lejet). This was because the kebele agricultural office agents are the close partners of the project, GIZ, in disseminating the stove (Mirt). The mandate to disseminate improved cookstoves in rural areas is given to MoARD (CRGE, 2011) with the practical reason that the MoARD has the best local network at Woreda and Kebele level agricultural offices agents. The Woreda Water Office, through rural energy case team, was also the one which has vested with the responsibility to disseminate Mirt stove in implementing Ethiopia National Clean Cookstoves Program.

3.5 Data Collection and Instruments

Different instruments and procedures were used to collect data. These instruments and procedures of this thesis are discussed hereunder.

3.5.1 Data Collection Instruments

Questionnaire: A structured questionnaire was administered. The researcher developed the questionnaire in English and translated into Amharic. The questionnaire, which takes 25-30 minutes to fill, included information about rural households' gender-based responsibility and fuel type and consumption, the respondent's characteristics, the presence of separate kitchen, source of fuel wood, the price of Mirt stove, institutional and social factors as well as Mirt stove adoption barriers.

Interview: Interviews were used to explore variables under investigation in greater detail. Semi-structured interviews were held with the key informants of Mirt stove producers in each kebele, the Woreda agriculture office, Woreda water offices (rural energy experts) and kebele agricultural offices agents (natural resource management experts) in their respective office. The duration of interview with key informants ranges between the minimum of 12 minutes and the maximum of 28 minutes. The focuses of the interviews with the key informants were institutional factors like how, when and where the stove is disseminated and households to be informed, local forest protection, about the services and supports provided

by the institutions for both the producers and potential users and the most likely barriers of Mirt stove production and adoption.

Focus Group Discussion: To supplement the interviews about institutional factors, four focus group discussions were held with the presence of key informants of Mirt stove producers, the Woreda agriculture office, Woreda water office (mainly rural energy experts) and kebele agricultural offices agents (mainly natural resources management experts). The first three discussions were held in the presence of nine of the key informants. These discussions were conducted after lunch for 10-15 minutes for each by using the opportunity that a meeting has been conducted for three consecutive days for Woreda and kebele agriculture development agents at Dembecha town and three days training for Mirt stove producers by Woreda rural energy experts. The fourth discussion was conducted for 8 minutes in the presence of one producer, the Woreda agriculture office and two rural energy experts at Dembecha town. The key informants' response was found to be similar with the second and third discussions and then the researcher understood that holding extra discussions would not add value.

3.6 Data Collection Procedures

Since the study was conducted in three rural kebeles, three enumerators have involved in data collection that are fluent in Amharic, one to each kebele. In order to collect the true data from the respondents the enumerators took two hours training about the questions, when, where, how and to whom the questionnaire to be distributed. The questionnaire was used as the basis of structured interviews, rather than self-completed, since the respondents' literacy level was found low. Only 2 women can read and write Amharic form the total of 11 randomly taken women for questionnaire pre-test purpose in Lejet rural kebele. The data were collected within three weekends in the morning and afternoon. This was because since the respondents are farmers it was in Sebastian days that enumerators more probably get the respondents free of work at home. Each enumerator spent the full weekend's days in respected kebeles and the researcher has supervised the enumerators. The semi-structured interviews and the focus group discussions with key informants were held by the researcher within three weeks side to side the questionnaire.

With regard to consent, since the majority of respondents were unable to read and write, the interviewers did read the written consent form to the respondents and the orally informed consent was obtained from each respondent. With the concern of cooperation, each respective kebele agricultural office agents have highly cooperated in informing and persuading farmers to cooperate with the enumerators as well as in administering and collecting the structured questionnaire.

3.7 Data processing and Analyzing

The collected data were processed and analyzed. These data processing and analyzing procedures are discussed below.

3.7.1 Data Processing

To reduce incompleteness and make it useful in the analysis, the raw data were filtered. To solve the problems related with inappropriate responses, incomplete answers and other fictitious responses, the raw data was edited, coded, grouped, tabulated and summarized with the help of SPSS software version 16 and STATA version 12.

3.7.2 Analyzing Procedures

Descriptive Statistics: The descriptive statistics of frequency, percentage, means and standard deviation were used by using the SPSS software version 16 while econometric analysis done by STATA version 12 in analyzing the data collected through questionnaire. The data collected through semi-structured interviews and focus group discussions were analyzed by the use of intensive textual analysis.

Econometrics: Binary logistic regression model was used. Since the dependent variable (adoption of Mirt stove) was in dichotomous (dummy) form, binary logistic regression was used to predict the effects of the independent variables on the dependent (outcome) variable. Logistic regression is used to model the probability of a positive outcome for a binary 0 or 1 outcome variable as a function of covariates (Gujarati, 2004).

3.8 Operational Definitions and Descriptions of Variables

This study included variables of Mirt stove adoption, household characteristics, and source of wood, price, institutional and social factors. Hereunder these variables are defined and described.

Dependent variable: Mirt stove adoption (msa) was given a value of '1' to the Mirt stove adopters while '0' was assigned to non-adopter. To assess the status of Mirt stove adoption by rural households, respondents were asked whether they purchased Mirt stove or not in the form of 'Yes' or 'no' response question. Similar studies, for instance, (Inayat, 2011; Dawit, 2008) used such type objective response and direct measure of binary dependent variable in determining the purchasing practice of Mirt stove.

Independent variables: The independent variables were selected based on the existing theories and empirical studies (Puzzolo et al, 2013; Damte & Koch, 2011; Rogers, 2003; Masera et al, 2000). The definitions of these selected explanatory variables are given below.

Age (age): Here refers to the respondent's age in years.

Age square (age-sq): Here refers to the respondent's age square in years to identify the possible non-linear effect of age.

Literacy level (litlevel): By level of literacy in this study is a dummy which refers to whether the respondent is literate (can read and write) or illiterate (cannot read and write). A value of '1' was assigned for literate and '0' for illiterate.

Marital status (marstat): In this study marital status is a dummy which refers to the respondent's state of being single or married. A value of '1' was given to married and '0' for single.

Family size (famsize): It is the total number of persons in a household.

Separate kitchen (sepakich): It is about whether the household has separate kitchen house or not. In this study separate kitchen is a dummy valued '1' for a household that has separate kitchen and '0' for has not.

Source of wood (sowood): It is about a household's main source of fuel-wood for the household. And for this study purpose, wood source is a dummy that refers to whether households get fuel-wood without charge, regardless of whether they collect from open forest or self grown, or with charge. A value of '1' was given for households that get wood without charge and '0' for with charge.

Price (price): Here price refers the end users cost to buy Mirt stove in Ethiopia Birr.

Institutional factors: Institutional factors in this study included provision of services (e.g. awareness creation, quality control and price regulation) and supports (e.g. technical, material and financial), decentralization of Mirt stove production sites to the potential users and the role of institutions in denying the access to open local forests.

Social factors: Social factors included in this study included membership to social associations, participation in social activities, the influence of informal information exchange, the influence of early Mirt stove adopters and the influence of neighbors.

3.9 Model Specification

To model regressions when the dependent variable is dichotomous, taking 0 or 1 values, there is a need of a probability model that has these two features: (1) as Xi increases, Pi = E(Y = 1 | X) increases but never steps outside the 0–1 interval, and (2) the relationship between Pi and Xi is nonlinear; thus, one can easily use cumulative distribution function (Gujarati, 2004). Both Logistic and Probit regression models satisfy the above two requirements. But, even though there is no basis in statistical theory for preferring one over the other, there are two practical advantages of the logit model over probit model (Fox, 2010). The first one is its simplicity: the equation of the logistic CDF is very simple. The second is its interpretability: the inverse linearizing transformation for the logit model is directly interpretable as log-odds, while the inverse transformation for probit does not have a direct interpretation. By taking in to consideration these advantages, the researcher preferred to use binary logistic regression model to predict the effects of independents variables on the dependent variable.

Therefore, a household's Mirt stove adoption probability was modeled as a dichotomous variable with values 1 'if a household adopts Mirt stove' and 0 'otherwise'. Here the dependent variable was dichotomous, i.e. to adopt or not to adopt: thus, the independent variable Yi = 1 if the household adopt the stove, and *Yi* = 0 if the household do not adopt. To adopt or not to adopt in relation to independent variables can be depicted in linear probability as follow:

$$Pi = E(Y = 1|Xi) = \beta 1 + \beta 2Xi$$

Where X is the independent variable and Y=1 means the household adopts the stove; thus, the adoption of Mirt stove can be expressed as follow;

$$Pi = E(Y = 1|Xi) = \frac{1}{1+exp[-(\beta 1+\beta 2Xi)]} = \frac{1}{1+\exp(-zi)} \text{ .... (1)}$$

Where Zi = $\beta 1 + \beta 2Xi$. It is this equation (1) known as the cumulative logistic distribution function (CDF). Here Zi ranges from $-\infty$ $to + \infty$; Pi ranges between 0 and 1; Pi is non-linearly related to Zi (i.e. Xi); thus, satisfying the two conditions required for a probability model. But, this non-linearity of Pi both in X and β's creates a problem in estimating parameters. To overcome this problem, there is a need of another equation. Here, Pi is the probability of adopting and it is given by;

$$\frac{1}{1 + \exp(-zi)}$$

Then the (1-Pi), the probability of not adopting, is;

$$(1 - \text{Pi}) = \frac{1}{1 + \exp(-zi)}$$

Therefore, one can write:

$$\frac{Pi}{(1-Pi)} = \frac{1+\exp(Zi)}{1+\exp(-zi)} \text{.. .... (2)}$$

Pi/(1-Pi) is the odds ratio in favor of adopting the Mirt stove, i.e.; the ratio of the probability that a household will adopt the stove to the probability that it will not adopt the stove. Taking the natural log of equation (2), one can obtain;

$$\ln(Pi/1-Pi) = Zi = \beta 1 + \beta 2\, Xi \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

This log of odds ratio is linear both in X and in the parameters. Therefore, the logit model of adoption for the sample respondent households was expressed as follows; with intercept term (βo) and Xi independent variables can be equated as:

$$\ln(Pi/1-Pi) = \beta o + \beta 1X1i + \beta 2\, X2i\ + \cdots + \beta kXki$$

Here, βo stands for the intercept term, while Xk are the hypothesized determinants of Mirt stove adoption, and βk are the parameters to be estimated. Hence, the logit model for adoption of Mirt stove was a function of respondent's age, marital status and level of literacy, family size, separate kitchen house, source of fuel-wood and price of Mirt stove. Similar to previous studies (Inayat, 2011) to identify the possible non-linear effect of age on Mirt stove adoption decision age square was included in the model. Therefore, the model employed has the following form, with the error tem:

$$\mathrm{P(msa)} = \ln\left(\frac{Pi}{1-pi}\right) = \beta o + \beta 1age + \beta 2\, agesq + \beta 3marstat + \beta 4litlevel +$$

$$\beta 5famsize + \beta 6sepakich + \beta 7sowood + \beta 8price + u$$

3.9.1 Diagnostic Tests

Before the start of complete analysis, various diagnostic tests were conducted to make the data ready for regression. Any analysis should incorporate a thorough examination of logistic regression diagnostics before reaching a final decision on model adequacy (Hosmer et al, 1997).

Model-Fit test is one of the most useful tests for truly assessing model fit for binary logistic regression models (Gujarati, 2004). To assess the usefulness of the model in indicating the amount of variation in the dependent variable, the Cox & Snell R Square and the Nagelkerke R Square, described as pseudo R^2- statistics (from a minimum value of 0 to a maximum of approximately 1) were tested. Since pseudo R^2 was found 0.3878, the model was fitted well. In a rule of thumb p-value of 0.05 is taken as a reference in assessing the goodness-of-fit test. In this study the prob > chi2 was found to be 0.6809 which is greater than 0.05 (see appendix

A). Thus, the model was good. Normality test was also checked by using Ladder-of-powers quantile-normal plots.

To test the correlation between variables included in the model pair-wise correlation test was run. As general rule, multi-collinearity is a problem when the correlation result is above 0.80 and below -0.80 (Stock & Watson, 2007). The coefficients of all variables were found to be above -0.4833 and below 0.6084 (see appendix B). In addition, Variance Inflation Factor (VIF) and tolerance level (1/VIF) are two important measures of multi-collinearity problem (Wooldridge, 2002). According to Wooldrige, by rule of thumb, VIF value of 10 or tolerance indexes of 0.10 are used as a critical point to indicate serious multi-collinearity problem. And, the minimum and maximum VIF values for this test were found 1.09 and 2.48, respectively, with mean value of 1.51 (see appendix B). Therefore, there was no severe multi-collinearity problem.

Table 3.2: Summery of Model Diagnostic Tests

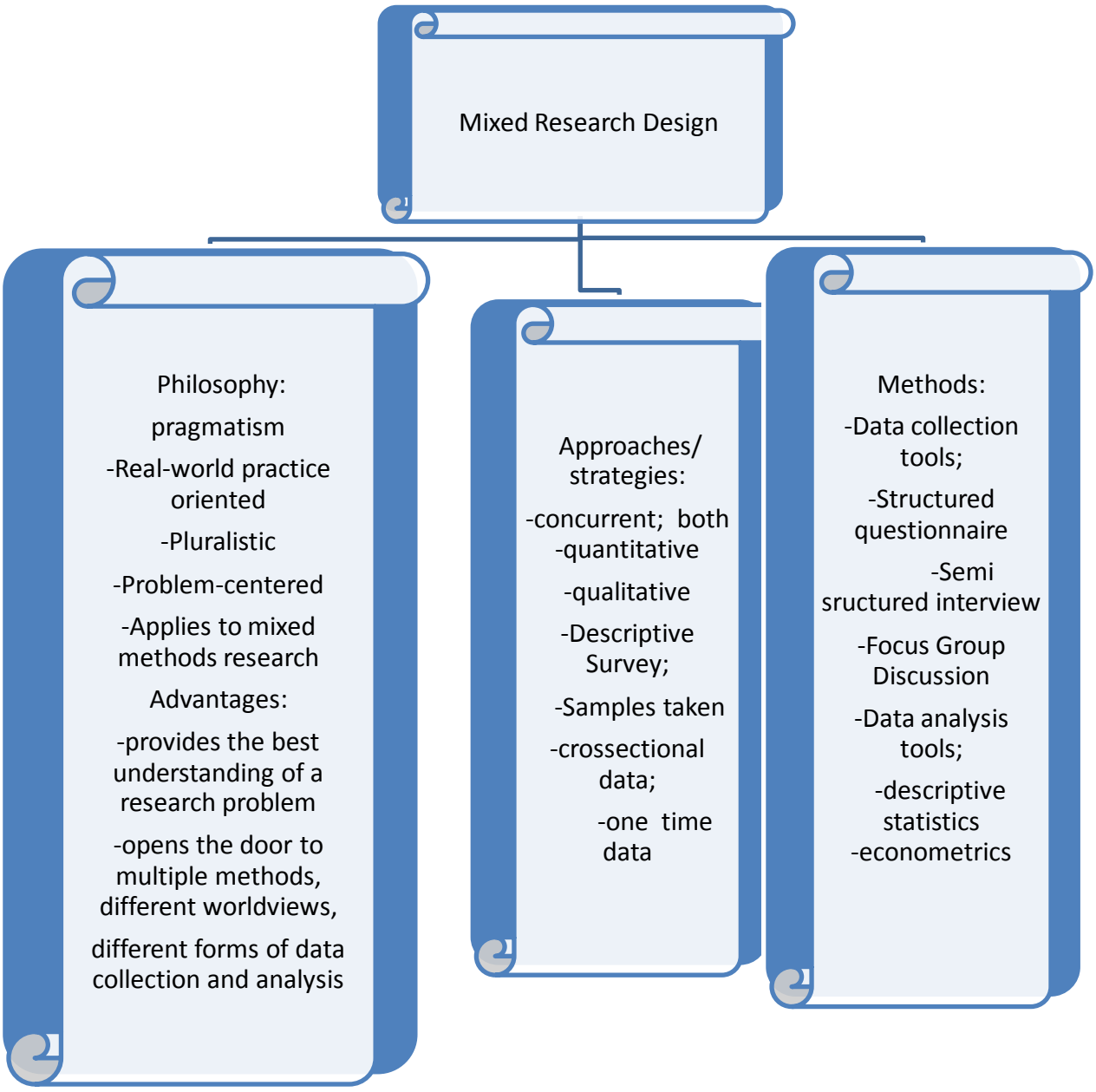
Tests	Test names	Prob>chi^2/F-value
gof	Pearson (chi^2)	0.6809
ovtest	Ramsey RESET	0.2104
linktest	hatsq	0.733
hettest	Breusch-Pagan/Cook-Weisberg	0.2740
vif	Minimum=1.09 and Maximum=2.48	Mean=1.51

Source: Own dataset (2014)

Ramsey RESET test using powers of the fitted values of adoption was, also, run to detect model specification bias. And the 'Ho: model has no omitted variables' was accepted with insignificant p-value of 0.2104 (see appendix C). The Link test was run to test the model specification error. And while the **hat** was found significant with p-value of 0.000, **hatsq** was found to be insignificant with p-value of 0.733 (see appendix C). Therefore, the model was modeled correctly and no important omitted variable(s). Breusch-Pagan/Cook-Weisberg test was run for checking heteroskedasticity problem and 'Ho: constant variance' was accepted with insignificant p-value of 0.2740 (see appendix C). Therefore, there was no heteroskdasticity problem.

To generalize, this study's research design and methods were summarized in a figure form as follow;

Figure 3.2: Research Design and Methods Summery



Source: Adapted from Creswell (2009) with some modification

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

This chapter presents the analysis, discussion and interpretation of the responses and reactions gathered through the structured questionnaire, semi-structured interviews and focus group discussion. Descriptive statistics and econometric analyses were employed. The relationship, direction of association between the Mirt stove adoption and the explanatory variables and the effect of the explanatory variables on the dependent variable are also presented.

4.1 Descriptive Statistics and Discussion

To identify factors affecting rural households' Mirt stove adoption decision, a systematic sample of 223 households from the sample frame were taken from three purposively selected rural kebeles in Dembecha Woreda. From this total of sample, 217 (97.3% response rate) household respondents were reached. But, the data gathered from 7 respondents were found to be incomplete. As a result, only data collected from 210 observations were used for the analysis purpose. Analyzing the reliability of the scale of items is one of the important tasks before analyzing the questionnaire (Taylor, Sinha & Ghoshal, 2011). So that, using Cronbach's alpha, the overall reliability of the questionnaire is indicated to be 0.84 which is above the minimum acceptable value (0.7) (see appendix C).

4.1.1 Food Preparation and Wood Supply Responsibilities in Rural Households

As Table 4.1 reveals, in households in which both females and males live together females are more responsible for use of fuel for household consumption in utilizing cooking appliances to prepare food and bake Injera. With regard to fuel-wood supply for the household consumption, for 52 % of respondents females were found to be more responsible while 29 % of respondents indicated males as more responsible. Children and both males and females were found to be more responsible to supply fuel-wood for 10.5 % and7.6 % of respondents, respectively.

From this one can understand that females are the ones responsible for use and supply of fuel for household consumption. From this we can infer that females are the victims of the adverse effects of preparing food and collecting fuel-wood as compared to male counterparts, in one hand and on the other hand, females are the primary beneficiaries of fuel efficient improved cooking technologies as compared to male household members.

Table 4.1: Cooking and Wood Supply Responsibilities in Rural Households

Responsibility		Frequency	Percent
More responsible to fulfill cooking appliances	Females	210	100.0
	Total	210	100.0
More responsible to prepare food	Females	210	100.0
	Males	0	0.0
	Total	210	100.0
More responsible to bake injera	Females	210	100.0
	Males	-	-
	Total	210	100.0
More responsible for fuel wood supply	Males	61	29.0
	Children	22	10.5
	Females	111	52.9
	Females and males	16	7.6
	Total	210	100

Source: Own survey data (2014)

4.1.2 Type of Fuel and Energy Consumption Pattern in Rural Households

As Table 4.2 shows, for 187 respondents (89 %), wood was found to be the household's main source of energy for cooking. Crop residuals, plant leaf and animal wastes were also found to be the main source of energy for cooking for 23 respondents (11 %). With regard to cooking practices, Injera baking was found to be the largest energy consuming practice for 68.1 % of respondents while 31.9 % of the respondents considered water heating and others as the largest energy consuming practices. With regard to cooking practices, 57.6 % of respondents indicated wood as the largest source of energy for Injera baking while crop residuals, plant leaf and animal waste were the sources of fuel for 23.3 %, 7.1 % and 11.9 % of respondents, respectively.

Table 4.2: Energy Sources and Consumption in Rural Households

Household energy		Frequency	Percent
Household's main sources of energy	Wood	187	89.0
	crop residuals, plant leaf and animal waste	23	11.0
	Total	210	100.0
The largest energy consuming cooking practice	Injera baking	143	68.1
	Water heating and others	67	31.9
	Total	210	100.0
The main source of energy for injera baking	wood	121	57.6
	Crop residuals	49	23.3
	plant leaf	15	7.1
	Animal waste	25	11.9
	Total	210	100.0

Source: Own survey data (2014)

From the above analysis it can be understood that for most households, wood is the main source of energy for cooking and of the cooking activities, baking Injera is the primary activity in terms of its energy requirement from fuel wood. This may be because since Injera is the staple food in Ethiopia, in each household Injera is eaten. So as to feed household members, Injera may be made frequently which leads to consume much fuel-wood as compared to other cooks. This heavily dependency of wood and crop residuals and leafs as sources of energy in rural areas may have implication to deforestation and farm lands productivity.

4.1.3 Status of Mirt Stove Adoption

To assess the status of Mirt stove adoption by rural households in Dembecha Woreda, household respondents(women) were asked whether they purchased Mirt stove or not in the form of 'Yes' or 'no' response question. Similar studies, for instance, (Inayat, 2011; Dawit, 2008) used such type objective response and direct measure of binary dependent variable in determining the purchasing practice of Mirt stove. As a result, for the purpose of investigating common explanatory variables affecting households' Mirt stove adoption decision, both households who did adopt and did not adopt were included in the analysis.

Table 4.3: Status of Mirt Stove Adoption

Adoption	Number of households	Percent
Non-adopters	133	63.3
Adopters	77	36.7
Total	210	100.0

Source: Own survey data (2014)

As it is observed in Table 4.3, from the total of 210, 133 respondents (63.3 %) were found non-adopters of Mirt stove while 36.7 % are adopters. This implies the majority of the households were found to be non-adopters.

Reasons to adopt Mirt stove: To investigate the most important reasons for the adoption of Mirt stove, only Mirt stove adopters (77 respondents) were asked. As the following table shows, the perceived relative benefits of Mirt stove over open-fire were found to be the most important reasons to adopt this improved cooking technology.

Table 4.4: Reasons to Adopt Mirt Stove

	Mirt stove saves wood		Mirt stove is cleaner cooking		Mirt stove is safer to use		Mirt stove is quicker cooking	
Responses	No	Percent	No	Percent	No	Percent	No	Percent
Strongly disagree	-	-	-	-	-	-	-	-
Disagree	-	-	-	-	-	-	10	13.0
Neutral	5	6.5	3	3.9	3	3.9	14	18.2
Agree	24	31.2	20	26.0	27	35.1	34	44.2
Strongly agree	48	62.3	54	70.1	47	61.0	19	24.7
Total	77	100.0	77	100.0	77	100.0	77	100.0

Source: Own survey data (2014)

As Table 4.4 presents, out of 77 Mirt stove adopters, 48 (62.3 %) strongly agreed that Mirt stove's perceived wood saving advantage is important reason to adopt it. From the total of 77 adopters, 54 (70.1 %) strongly agreed that cleaner cooking perception on Mirt stove is the reason to adopt. Out of the surveyed 77 adopters of Mirt stove, 47(61 %) strongly agreed that perception of safer to use is one important justification to purchase Mirt stove. 34 (44.2 %) of respondents agreed and 19 (24.7 %) strongly agreed that quicker cooking is the other reason

to adopt Mirt stove. Therefore, these findings indicate that the probability of a household's Mirt stove adoption preference is based on its cleaner cooking, safer use, wood saving and prompt cooking. This finding is similar to the previous studies (Bubendorfer, 2011; Holmes, 2010; Shanko, 2001) that found cleaner cooking, safer to use, wood saving and quicker to cook to be the main reasons to purchase improved cookstove technologies.

Awareness and source of information: Table 4.5 shows that from the total of 210 surveyed women respondents, 115 (54.8 %) were found unaware of the relative benefits of Mirt stove over open fires while 95 (45.8 %) were found to be aware. And also, 190 (90.5 %) respondents replied that they are aware of the adverse effects of baking Injera on open-fire like eye irritation and burn while 20 (9.5 %) replied that they are unaware.

Table 4.5: Awareness and Sources about Mirt Stove and Open-fire

Awareness and sources	Categories	Total	
		No	Percent
About the benefits of Mirt stove	Yes	95	45.2
	No	115	54.8
	Total	210	100.0
About the adverse effects of open-fire	Yes	190	90.5
	No	20	9.5
	Total	210	100.0
More accessible source of information	Government agents	87	41.4
	Media	36	17.1
	Mirt stove producers	29	13.8
	Social associations	55	26.2
	Others	3	1.4
	Total	210	100
More accessible place/s to be informed	Religious places	71	33.8
	Natural resource mgt works	68	32.4
	Market places	25	11.9
	Meeting places	46	21.9
	Total	210	100

Source: Own survey data (2014)

Based on the above findings one can deduce that though majority of rural women found to be aware about the adverse effects of baking on open-fire, the majority were unaware about the

benefits of Mirt stove. This may be because rural women unable access different sources of information since they spend most of their time at home to carry out in door tasks.

With regard to sources of information, as Table 4.5 shows, government agents and social associations were found to be more accessible for 41.4 % and 26.2 % of respondents, respectively. Media (mainly radio), Mirt stove producers and others also were found to be more accessible sources of information for 17.1 %, 13.8 % and 1.4 % of respondents, respectively. With regard to place, religious places (example, church and mosque) and natural resource management works (e.g. terracing work) were found to be more accessible to get information for 33.8 % and 32.4 % of respondents, respectively. Meeting places and market places were found to be more accessible for 21.9 % and 11.9 % of respondents, respectively.

From the above analysis we can infer that government agents, social associations, media and producers of Mirt stove are found to be more accessible sources of information for rural women at the study area. And also religious places, natural resource management works, meeting places and market places are identified to be more accessible sources of information for rural women. These may be because, for instance, health extension workers give awareness creation services about the adverse effects of indoor air pollution. Kebele natural resource management agents create awareness on sustainable management of resources such as forests during natural resource management works and meetings in which every person above 18 years old is subjected to participate. And also by social association, there will be information and experiences exchanges informally.

4.1.4 Mirt Stove Adoption and Household Characteristics

Household characteristics are those variables that explain information about the household such as respondent's gender, age, and marital status, level of education and occupation. But, for this study, household characteristics include only variables of the respondent's age, marital status, literacy level, family size and household's separate kitchen ownership. These factors are explained below.

Mirt Stove Adoption and Age

As it can be seen from Table 4.6, the minimum and maximum years of the respondents are 21 and 67 while the mean and standard deviation are 39.99 and 10.765, respectively. The minimum and maximum years of the adopters are 21 and 66 while 23 and 67 years are for the non-adopters, respectively. And also, while the means for adopters and non-adopters is 37.6 and 41.37, the standard deviations for adopters and non-adopters are 10.659 and 10.621, respectively. This finding reveals that there is mean variation between the Mirt stove adopters' and the non- adopters' age. The average age of adopters is less than the average age of non adopters. This implies that the younger the age, the more likely to be Mirt stove adopter. In addition, this mean variation was found to be statistically significant with t-value of 2.677. This t-value suggests that there is significant difference between the mean of Mirt stove adopters and the mean of non-adopters at ($P<0.01$) level of significance.

This implies that the younger the age, the more to be Mirt stove adopter and the older the age the more to be Mirt stove non-adopter and vice versa. This may be because of older people are found to be more conservative towards accepting new technologies and instead they prefer to continue using the technology they are habituated. This finding is in harmony with the works of Lewis and Pattanayak (2012) and Gebreegziabher et al (2010) that found statistically significant relationship between age and Mirt stove adoption decision.

Mirt stove Adoption and Family Size

As it can be seen from Table 4.6, the minimum and maximum family size is 1 and 11, respectively while the mean and standard deviation are 5.10 and 2.060, respectively. And also, the minimum and maximum family size for Mirt stove adopters and non-adopters were found to be the same, 1person and 11persons, respectively. The mean of adopters (5.13) slightly exceeds the mean of non-adopters (5.05) and the standard deviation of non-adopters (2.105) slightly exceeds the standard deviation of adopters (1.993). Though there is a little bit mean difference in family size of both the adopters and non-adopters, the t-value shows that there is insignificant relationship between the family size of the adopters and non-adopters decision to adopt Mirt stove.

Table 4.6: Mirt Stove Adoption, Age and Family Size

Variables	Mirt stove adoption	Min	Max	Mean	St.dev	t-value
Age	Total	21	67	39.99	10.765	2.677
	Non-adopters	23	67	41.37	10.621	
	Adopters	21	66	37.60	10.659	
Family size	Total	1	11	5.10	2.060	.6535
	Non-adopters	1	11	5.05	2.105	
	Adopters	1	11	5.13	1.993	

Source: Own survey data (2014)

Mirt Stove Adoption and Marital Status

Table 4.7 shows that out of 210 surveyed households, 186 are married in which 64 of them are Mirt stove adopters and 122 of them are non-adopters while 24 are single in which 13 are Mirt stove adopters and 11 of them are Mirt stove non-adopters. The majority (54.17 %) of single women were found to be Mirt stove adopter while the 34.41 % of married women were found to be adopter.

Table 4.7: Mirt Stove Adoption and Marital Status

Marital status	Mirt stove adoption			Total	Chi^2-test P-value
	Adopter		Non-adopter		
Single	No	13	11	24	
	percent	54.17	45.83	100	
Married	No	64	122	186	0.059*
	Percent	34.41	65.59	100	

Source: Own survey data (2014) NB: * indicates the level of significance at 10 %.

As Table 4.7 shows, the majority (65.59 %) of married women were found to be non-adopter of Mirt stove in the study area. These figures indicate that a greater proportion of single women tended to adopt Mirt stove as compared to married counterparts. In addition, the chi-square statistic showed this to be statistically significant with P-value of 0.059. Therefore, it can be conclude that there is significant relationship between marital status and Mirt stove adoption decision at ($p<0.1$) level of significance.

From this finding one can understand that single women were more likely to adopt Mirt stove as compared to married counterpart. One plausible explanation for this may be because of single women has the full power to make economic decision in the household as compared to married ones. This implies that married women were found lagged behind single women to be Mirt stove adopters and it may be because of lack of power to make economic decisions in the household, since, in patriarchal society, the husband is more powerful in making economic decisions. This finding also supports household energy stacking theory that argues in addition to economic factors, there are factors which affect a household's fuel and/or technology switching and/or adoption decision. This study's finding consistent with previous studies (Damte & Koch, 2011; Adrianzen, 2009) that found single women (female headed households) to be more likely in adopting improved cooking technologies than married (male headed households).

Mirt Stove Adoption and Literacy Level

As Table 4.8 shows, from the total of 210 respondents, 167 (79.5 %) were found illiterate in which 40 of them are found to be Mirt stove adopters and 127 of them are non-adopters. On the other side, 43 (20.5 %) are found literate in which 37 are found to be Mirt stove adopters and 6 of them are non-adopters. And also the proportion of literate Mirt stove adopters (48.1 %) largely exceeds the proportion of literate Mirt stove non-adopters (4.5 %) while the proportion of illiterate Mirt stove adopters (51.9 %) much less than the proportion of illiterate Mirt stove non-adopters (95.5 %). This percentage difference was indicated to be significant with P-value of 0.000. Therefore, it can be generalized that there is significant relationship between women literacy level and the probability of Mirt stove adoption decision at ($p<0.01$) significance level.

From this finding one can deduce that literate women are found to be more Mirt stove adopters as compared to the illiterate women. This may be because literate women are more likely to be aware of the benefits of improved cookstoves as compared to uneducated. This finding also supports household energy stacking theory that argues in addition to economic factors, there are factors which affect a household's fuel and/or technology switching and/or adoption decision. This finding is similar to the previous empirical works of (Puzzolo et al,

2013; Damte & Koch, 2011; Inayat, 2011; Tsangari, 2010) that found the higher education level of woman (wife) in a household has a positive effect on the likelihood of the household to adopt improved cookstove technologies.

Mirt Stove Adoption and Separate Kitchen

Table 4.8 shows, out of surveyed 210 household respondents, 180 (85.7 %) have separate kitchen house in which 74 of them are Mirt stove adopters and 106 of them are non-adopters. On the other side, 30 (14.3 %) have not separate kitchen in which 3 of them are found to be Mirt stove adopters and 27 of them are non-adopters.

These imply that households that have separate kitchen house are found to be more Mirt stove adopters as compared to households that have not separate kitchen. This may be because of its fixed nature and larger in size which requires larger space. This result is consistent with the previous works of (Puzzolo et al, 2013; Axen, 2012; Damte & Koch, 2011) that found households that have separate kitchen house are more likely to adopt improved cookstove technologies as compared to households that have not separate kitchen.

Table 4.8: Mirt Stove Adoption, Literacy Level and Separate Kitchen

		Mirt stove adoption				Total		Chi^2-test
		Adopters		Non-adopters				
variables	Categories	No	percent	No	Percent	No	Percent	P-value
Literacy	Illiterate	40	51.9	127	95.5	167	79.5	
level	Literate	37	48.1	6	4.5	43	20.5	
	Total	77	100	133	100	210	100	.000***
Separate	Yes	74	96.1	106	79.7	180	85.7	
kitchen	No	3	3.9	27	20.3	30	14.3	
	Total	77	100	133	100	210	100	.001***

Source: Own survey data (2014)

NB: *** indicates 1% level of significance.

The above table shows that the proportion of Mirt stove adopters (96.1 %) who have separate kitchen largely exceeds the proportion of Mirt stove non-adopters (79.7 %) who have separate kitchen. On the other hand, the proportion of Mirt stove adopters (3.9 %) who have

not separate kitchen largely less than the proportion of Mirt stove non-adopters (20.3 %) who have not separate kitchen. Moreover, the chi-square statistic revealed that there is significant relationship between separate kitchen and the probability of Mirt stove adoption decision at ($p<0.01$) significance level. As a result, households with separate kitchen are more probably to adopt Mirt stove.

As Table 4.9 shows, out of 210 surveyed women, 121 (57.6 %) strongly agreed that Mirt stove's fixed nature is one reason for the need of separate kitchen to adopt. This implies that the nature of Mirt stove influences households' Mirt stove adoption decision.

Table 4.9: Reasons for the Need of Separate Kitchen

Response	Having kitchen room can affect Mirt stove adoption decision		Mirt stove's fixed nature is one reason the need for separate kitchen	
	No	Percent	No	Percent
Strongly disagree	-	-	-	-
Disagree	2	1.0	1	.5
Neutral	66	31.4	69	32.9
Agree	52	24.8	19	9.0
Strongly agree	90	42.9	121	57.6
Total	210	100.0	210	100.0

Source: Own survey data (2014)

4.1.5 Mirt Stove Adoption and Source of Fuel-wood

As it is presented in Table 4.10, from the total of surveyed 210 respondents, 118 (56.19 %) get fuel-wood without charge in which 19 of them are found to be Mirt stove adopters and 99 of them are found to be non-adopters. On the other hand, 92 (43.81 %) get fuel-wood with charge in which 58 of them are found to be Mirt stove adopters and 34 of them are non-adopters. And also, the proportion of those who get their fuel-wood with charge Mirt stove adopters (75.32 %) largely exceeds the proportion of those who get their fuel-wood with charge Mirt stove non-adopters (25.56 %). On the other side, the proportion of those who get fuel-wood without charge Mirt stove non-adopters (74.44 %) largely exceeds the proportion of those who get fuel-wood without charge Mirt stove adopters (24.68 %). This analysis reveals that those who get their fuel-wood with charge are found to be more Mirt stove

adopters as compared to those who get fuel-wood for free of charge. The chi-square statistic also showed this one to be significant with p-value of 0.000. This p-value implies that source of wood and Mirt stove adoption decision are found to be related at ($p<0.01$) significance level. From this we can deduce that there is statistically significant relationship between source of wood and rural households' Mirt stove adoption decision.

This implies that the more a household's source of fuel-wood is with charge, the more likely to be found Mirt stove adopter and vice versa. The more likely reason is that for households that get wood for free, fuel-wood saving or efficient use of wood may not be their concern. On the other side, for households that get fuel-wood with charge fuel saving may be the priority. This finding is similar to the works of (Puzzolo et al, 2013; Axen, 2012; Damte & Koch, 2011; Inayat, 2011) that found those who get their fuel-wood with charge are found to be more improved cookstoves adopters as compared to those who get fuel-wood free of charge.

Table 4.10: Mirt Stove Adoption and Source of Fuel-wood

Source of wood	Mirt stove adoption				Total		Chi^2- test
	Adopters		Non-adopters				
	No	percent	No	Percent	No	Percent	P-value
Without charge	19	24.68	99	74.44	118	56.19	
With charge	58	74.32	34	25.56	92	43.81	0.000***
Total	77	100	133	100	210	100	

Source: Own survey data (2014)

NB: NB: *** are represents 1% level of significance.

4.1.6 Mirt Stove Adoption and Price

As it can be seen from Table 4.11, the minimum and maximum prices are 125 and 150, respectively. And also the mean and standard deviation is 133.38 and 10.464, respectively.

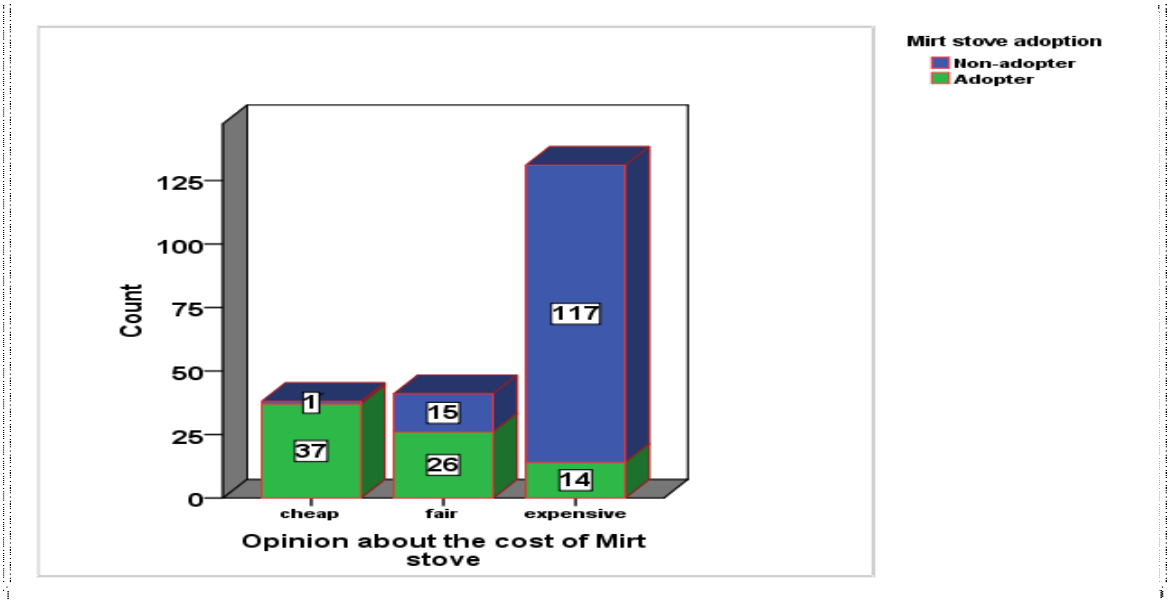
Table 4.11: Mirt Stove Adoption and Price

Variable	Min	Max	Mean	St.dev	t-value
price	125	150	133.38	10.464	111.006

Source: Own survey data (2014)

Opinion on Mirt stove price: As Figure 4.1 shows, majority of the respondents stated the price of Mirt stove is 'expensive' and represents the lion share in non-adopters, while those stated the price is 'cheap' represents the smallest proportion in non- adopters and the lion share in adopters.

Figure 4.1: Respondents' Perception on the Price of Mirt Stove and their Opinion



Source: Own survey data (2014)

From the above bar graph one can understand that the cheaper the price of Mirt stove, the more likely households to adopt Mirt stove and vice versa. In addition, t-value of 111.006 indicates that the price of Mirt stove is found to be significant for the adoption decision at ($p<0.01$) level of significance. This finding is similar with the empirical work of Axen (2012) that found positive perception about the improved cookstoves' price is one important factor that affects the adoption decision.

4.1.7 Mirt Stove Adoption and Institutional Factors

In examining institutional influence on rural households' Mirt stove adoption decision in the study area, institutional variables of denying open forest access, provision of services and supports and decentralization of Mirt stove production sites were analyzed. These institutional variables' influence on Mirt stove adoption decision is discussed below.

When series of likert-type questions/items are used to measure a single main variable or character, mean and standard deviation are more proper in analyzing the data than using of mode and median(Boone & Boone, 2012). In this study, denying access to open forest, providing services, providing supports and decentralizing Mirt stove production sites were five scale likert response questions (from 1=strongly disagree 3= neutral to 5= strongly agree) to examine institutional influence on households' Mirt stove adoption decision. As a result, the data were analyzed by using mean for central tendency and standard deviation for variability. So that, when the mean response is below 3 it indicates that the variable is either disagreed or strongly disagreed and when it is above 3 shows that either the variable is agreed or strongly agreed. In addition to mean, frequency and percentage were used.

Table 4.12: Mirt Stove Adoption and Institutional Factors

Items		SD	D	N	A	SA	Total	Mean	St.dev
Institutionally denying the access to open forest affects Mirt stove adoption decision.	frc	3	9	78	65	55	210	3.76	.939
	Pct	1.4	4.3	37.1	31.0	26.2	100		
Providing services (awareness creation, quality control) affect Mirt stove adoption decision	frc	-	14	42	87	67	210	3.99	.888
	Pct	-	6.7	20.0	41.4	31.9	100		
Providing supports (e.g. material and technical) affect the production and adoption of 'Mirt' stove.	frc	1	1	74	62	72	210	3.97	.872
	pct	.5	.5	35.2	29.5	34.3	100.		
Decentralizing Mirt stove's production site influences its availability and accessibility	frc	-	-	34	52	124	210	4.43	.756
	pct	-	-	16.2	24.8	59.0	100.0		
Decentralizing production site to users can reduce the probability of Mirt stove to be broken during transportation	frc	-	-	29	46	135	210	4.50	.727
	pct	-	-	13.8	21.9	64.3	100.0		
Decentralizing Mirt stove production site to users can reduce its cost, such as transportation cost	frc	-	-	20	38	152	210	4.63	.653
	pct	-	-	9.5	18.1	72.4	100.0		
Average	-	-		-	-	-	-	4.213	

Source: Own survey data (2014)

NB: SD=Strongly disagree, D= Disagree, N=Neutral, A=Agree, SA=Strongly agree

As Table 4.12 presents, denying open forest access, provision of services and supports and decentralization of Mirt stove production sites were found important factors that affect Mirt stove adoption decision with average mean of 4.21.

As it is observed from the above table, decentralization of Mirt stove production sites to the potential users that can reduce the cost of Mirt stove, with mean of 4.63, was found to be the most important institutional factor that affects households Mirt stove adoption decision at the study area. Consistent to this mean value, majority (72.4 %) of respondents strongly agreed that decentralization of Mirt stove production sites reduces the cost of Mirt stove. This may be due to Mirt stove's larger size and heavier weight to transport by users themselves: as a result, it may need other means of transportation that costs, in addition to its price. The variable that decentralization of Mirt stove production sites reduces the probability of the stove to be broken was found the other institutional factor in influencing Mirt stove adoption decision with mean of 4.50. In line with this mean value, majority (64.3 %) of respondents strongly agreed that decentralization of Mirt stove production sites reduces the probability of the stove to be broken. Two of the plausible explanations might be problematic topography or unleveled road and long distance transportation. In rugged road regions or areas the probability of adoption of Mirt stove declines due to its fragility during transportation. Likewise, in long distance transportation the fragility of stove increases; as a result, the probability of adoption of Mirt stove decreases.

The other institutional variable that decentralization of production sites influences the availability and accessibility of Mirt stove was found to be one factor with mean of 4.43. In line with this mean value, majority (59.0 %) of respondents strongly agreed that decentralization of production sites influences the availability and accessibility of Mirt stove. Denying open forest access, provision of services and supports were also found to be the other important institutional factors that affect Mirt stove adoption decision with mean of 3.76, 3.99 and 3.97, respectively. This may be, partly, because the role of institutions in creating an enabling working environment by providing different services and supports to Mirt stove producers can influence the production of Mirt stove. And in case of highly availability of Mirt stove and in expanded public awareness about its benefits, the probability of adoption may be high.

This descriptive analysis result was supported by the data gained from the key informants. The key informants responded that the nearby government institutions, through energy experts, health extensions, agriculture development agents and others such as schools, affect the production and rural household's Mirt stove adoption decision by providing different services such as awareness creation, training to both users and producers, quality control, price regulation, local forest protection and material and technical supports. The Woreda institutions mainly the Woreda agricultural office, the Woreda water office, through rural energy experts, provide stove accessories or basic hand tools such as spade and trowel as well as specialized facility such as Mirt mould and wooden boards to the producers. According to key informants, the other way institutions can influence rural households Mirt stove purchasing decision was decentralization of Mirt stove production sites into village level. They assert that if the Mirt stove production sites are decentralized at village and other lower levels, the costs incurred for transportation and the probability of the to be broken will be reduced, and this condition, in part, increases the interest of households to purchase Mirt stove.

The other institutional factor that affects the probability of Mirt stove adoption is the access to credit. All of the key informants agreed that the access to credit for the low income producers and consumers may help to overcome liquidity constraint to produce and purchase Mirt stove.

From these findings on can understand that denying open forest access, provision of services and supports and decentralization of Mirt stove production sites and personnel were found to be important institutional factors that affect Mirt stove adoption decision. This study came up with similar findings of Puzzolo et al (2013) and Agarwal (1983) that found extension (e.g. awareness creation) and financial access to the users and the producer positive institutional determinant factors for the adoption of improved wood-burning stoves. This study is also consistent with the empirical works of Makonese, Chikowore and Annegarn (2006) that found training, technology and information exchange, technology standard and decentralizing energy systems as institutional factors to influence the production, dissemination and adoption of improved cookstoves.

4.1.8 Mirt Stove Adoption and Social Factors

Social factors explain social relationships and networks, membership to social associations, the influence of others, the influence of neighbors', the influence of family members and other variables. But, for this study purpose the variables of membership to social associations, active participation in social activities, the influence of informal information exchange, the influences of earlier adopters and neighbors are discussed in examining social influences on Mirt stove adoption decision.

As Table 4.13 presents, from the total of surveyed 210 women, 113 (53.8 %) were not found member of three and above social associations in which 4 of them are Mirt stove adopters and 109 of them are non-adopters. On the other hand, 97 (46.2 %) of respondents were found member of three and above social associations in which 73 of them are Mirt stove adopters and 24 of them are non-adopters. This finding reveals that those women who were member of three and above social organizations were more found to be Mirt stove adopters as compared to not members. This investigation found that the proportion of women that were member of three and above social associations Mirt stove adopters (94.8 %) largely exceeds the proportion of women that were member of three and above social associations Mirt stove non-adopters (18 %). On the other hand, the proportion of women that were not member of three and above social associations Mirt stove non-adopters (82 %) largely exceeds the proportion of women that were not member of three and above social associations Mirt stove adopters (5.2 %). This implies that the more a woman is member of social associations, the more likely to be Mirt stove adopter. This factor helps rural households to get information and to share some experience from being of social association membership. The more the women participate in social association, the more likely to adopt new technologies of Mirt stove.

As it can be seen from Table 4.13, from the surveyed 210 women, 115 (54.8 %) were not active participant in associations and activities to which they are member in which 6 of them are Mirt stove adopters and 109 of them are non-adopters while 95 (45.2 %) were found to be active participant in associations and activities in which 71 of them are Mirt stove adopters and 24 of them are non-adopters. This result reveals that women who are active participant in

associations and activities were more found to be Mirt stove adopters as compared to passive ones. This study found that the proportion of women that were active participant in social associations and activities Mirt stove adopters (92.2 %) largely exceeds the proportion of women that were active participant in social associations and activities Mirt stove non-adopters (18 %). On the other hand, the proportion of women that were not active participant Mirt stove non-adopters (82 %) largely exceeds the proportion of women that were not active participant Mirt stove adopters (7.8 %).

These findings imply that the more a woman is member of social associations and active participant in social activities, the more likely to be Mirt stove adopter. This may be because of being a member to and active in participation open and increase the opportunity to contact with individuals who have different information and experience and by these social organizations there will be information exchange can influence Mirt stove purchasing decision. If a woman becomes a member of different social associations and becomes active participate, the opportunity of getting information about Mirt stove will be high. The finding of this research is similar to the works of Axen (2012) that found membership to social associations and be networked and Adrianzen (2009) that found a woman's participation in different associations and communal activities has significant positive effect on a household's improved cookstoves adoption decision.

Table 4.13: Mirt Adoption and Membership to and Participation in Social Associations

Social factors	Categories	Mirt stove adoption					
		Adopters		Non-adopters		Total	
		No	percent	No	Percent	No	Percent
Membership to , at least three, social organizations	Yes	73	94.8	24	18	97	46.2
	No	4	5.2	109	82	113	53.8
	Total	77	100.0	133	100.0	210	100.0
Active participation (secretary, chair-person and/or coordinator) in social activities	Yes	71	92.2	24	18	95	45.2
	No	6	7.8	109	82	115	54.8
	Total	77	100.0	133	100.0	210	100.0

Source: Own survey data (2014)

In this study, the influence of membership to local associations, information exchange by social associations, the influence of early adopters and neighbors were five scale likert response questions (from 1=strongly disagree 3= neutral to 5= strongly agree). As a result, the data were analyzed by using mean, standard deviation and percentage. So that, when the mean response is below 3 it indicates that the variable is either disagreed or strongly disagreed and when it is above 3 shows that either the variable is agreed or strongly agreed.

As it can be seen from the below table, informal information exchange by social associations with the mean of 4.43 was found to be the most important social factor that influences Mirt stove adoption decision in the study area. In line with this, majority (50 %) of respondents strongly agreed and 41.9 % agreed that informal information exchange can influence adoption decision. One explanation could be that by social associations members may exchange their different experiences and information about Mirt stove and this communication in turn affects Mirt stove purchasing decision. This finding is similar to the empirical studies of Dewan et al (2013) and Geary et al (2012) that found inter-personal communications and social networks are important social factors that affect households' improved cookstove technologies adoption decision.

Table 4.14: Mirt Stove Adoption and Influence of Social Factors

Items		SD	D	N	A	SA	Total	Mean	St.dev
Membership to local associations can influence Mirt stove purchasing decision	frc	-	3	38	82	87	210	4.20	.783
	pct	-	1.4	18.1	39.0	41.4	100		
By local associations there will be information exchange that can influence adoption decision	frc	-	1	14	88	107	210	4.43	.640
	pct	-	.5	6.7	41.9	51.0	100		
Earlier adopter of Mirt' stove can influence others adoption decision	frc	-	1	26	87	96	210	4.32	.705
	pct	-	.5	12.4	41.4	45.7	100		
Neighbors can influence the others Mirt stove adoption decision	frc	-	2	29	88	91	210	4.28	.732
	pct	-	1.0	13.8	41.9	43.3	100		
Average		-	-	-	-	-	-	4.342	

Source: Own survey data (2014)

NB: SD=Strongly disagree, D= Disagree, N=Neutral, A=Agree, SA=Strongly agree

As the above table shows, the other social factor that affects Mirt stove adoption was found to be early Mirt stove adopters with the mean of 4.32. Consistent to this mean value, majority (45.7 %) of respondents strongly agreed and 41.4 % agreed that earlier adopter of Mirt' stove can influence others adoption decision. This result supports Diffusion of Innovation Theory that asserts individuals and early adopters in a certain social system are able to influence attitude and behavior of others informally either to promote or hinder the acceptance of a new technology. This result is similar to the previous works of Puzzolo et al (2013) and Adrianzen (2009) that found households that adopted the improved stove have a positive or negative effect on the household's likelihood of adoption. Neighbors' influence was, also, found one social factor that has influence on Mirt stove adoption decision with mean of 4.28. Consistent to this mean value, majority (43.3 %) of respondents strongly agreed and 41.9 % agreed that neighbors can influence others adoption decision. In line to this study, Thandapani and Menon (2011) that found the influence of neighbors as one social factor to influence fuel efficient new cooking technologies adoption decision.

To generalize, membership to local associations, informal information exchange, the influences of early adopters and neighbors were found social variables that affect Mirt stove adoption decision with the average mean of 4.34.

4.1.9 Barriers of Mirt Stove Adoption

As it was discussed earlier, the majority of households (63.3 percent) in the study area were not found to be Mirt stove adopters due to different barriers. These barriers are discussed.

Table 4.15: Barriers of Mirt Stove Adoption

Combination of Barriers	Frequency	Percent
Lack of awareness Family reluctance(example, spouse) Higher price of the stove Problem of separate kitchen	107	51.0
Family reluctance Higher price of the stove	95	45.2

Problem of separate kitchen Shortage of Mirt stove supply		
Lack of awareness Higher price of the stove Problem of separate kitchen Shortage of Mirt stove supply	8	3.8
Total	210	100.0

Source: Own survey data (2014)

As it is observed from Table 4.15, majority of the respondents, 107(51 %) replied that lack of awareness, family members reluctance (for instance, spouse), higher price, problem of separate kitchen are the four most likely barriers of Mirt stove adoption. For 95 (45.2 %) respondents, also, family members' reluctance, higher price, problem of separate kitchen and shortage supply were found the first barriers of Mirt stove adoption in the study area. To generalize, lack of awareness about its health, economic, and environmental benefits, family members' reluctance, higher price, problem of separate kitchen and shortage of supply were found to be the five most likely barriers of Mirt stove adoption in the study area.

The data gained from key informants also support the findings of the descriptive analysis. The key informants also identified lack of awareness, lack of nearby availability and accessibility as the most likely barriers for the adoption of Mirt stove by the rural households. The main reason for rural households' lack of awareness about the relative benefits of Mirt stove was attributed to the absence of rural energy expert at kebele level. The key informants revealed that at kebele level there is no a person or an expert assigned by the government concerning Mirt stove. According to local Mirt stove producers, shortage of Mirt stove supply was found a result of shortage of inputs used for Mirt stove production, mainly shortage of river sand. The other barrier identified by these informants was higher cost of Mirt stove as compared to traditional open-fire (Sost-Gulcha). They explained that the higher cost is, in part, the result of centralized Mirt stove production sites. The key informants claimed that the Mirt stove's end users' cost(price) difference, that ranges 125-150 ETB, mainly comes from difference in distance between where Mirt stove production are found,

for example, cement, and Mirt stove production site. This distance difference results in difference in the transportation cost, in turn production and end users costs of Mirt stove.

In consistent to the above findings, in Woreda water office report (2013), lack of public awareness about the health, economic and environmental benefits of Mirt stove and shortage of the inputs of Mirt stove production were identified as the most likely barriers of Mirt stove adoption and production. In the report, shortage of Mirt stove availability was attributed to shortage of inputs of production such as river sand and cement. The reluctance of individuals who are trained to produce Mirt stove timely as per the agreement was also reported as one barrier of mass production. Those individuals who took trainings and the necessary materials failed to start producing Mirt stove.

The finding of the study is in harmony with the works of Puzzolo et al (2013) and Gebreegziabher et al (2010) that found the high cost of the stove was the main reason for not adopting the improved cookstoves and Slaski and Thurber (2009) that found low affordability of improved cookstoves as one barrier of adoption decision. This study's result is again similar to the study of Inyat (2011) that found lack of awareness about the relative benefits of improved cookstove technologies important barrier of adoption. This investigation came up with similar finding of that found the household head's low and/or negative interest towards improved one barrier of adoption. The study's finding also similar to the previous works of (Puzzolo, 2013; Axen, 2012; Damte & Koch, 2011; Adrianzen, 2009) that found separate kitchen problem important barrier for households to adopt improved cookstoves.

4.2 Econometric Analysis and Discussion

As discussed in chapter three, model specification diagnostic tests of overall model fit, multi-collinearity, model specification error, heteroskedasticity and normality were checked before applying logistic binary regression model to estimate the potential effect of each explanatory variable on the dependent variable of Mirt stove adoption. The results of these tests shows that no problems of sever multi-collinearity, model specification bias, heteroskedasticity and normality as well as the model well fitted the data. In addition to these tests, robust was run to get better estimations.

4.2.1 Binary Logit Model and Determinants of Mirt Stove Adoption

In the previous section, factors affecting rural households' Mirt stove adoption decision were analyzed using descriptive statistics. Further, to understand the extent to which these factors affect Mirt stove adoption decision binary logistic model was employed. The explanatory variables included and analyzed in the model are summarized in Table 4. 16.

Table 4.16: Summery of Variables Included in Logit Model

Variables	Type	code	Descriptions
Mirt stove adoption	Dummy	msa	'1' if the household adopt Mirt stove, otherwise '0'
Age	Continuous	age	Number of years
Age square	Continuous	age-sq	Square of years in number
Marital status	Dummy	marstat	'1' if the respondent is married and '0' if single
Literacy level	Dummy	litlevel	'1' if the respondent is literate and '0' if illiterate
Family size	Continuous	famsize	Total member of persons in the household
Kitchen	Dummy	sepakch	'1' if the respondent has separate kitchen and '0' if has not
Wood source	Dummy	sowood	'1' if the wood is for free and '0' if with charge
Price	Continuous	price	The price of Mirt stove in Birr

Source: Own construct (2014)

As Table 4.17 shows, the regression estimation result investigated that there are factors that have explanatory power to determine rural households 'Mirt stove adoption decision in the study area at 1 percent and 5 percent level of significance. This regression result shows that Mirt stove adoption decision is positively correlated with literacy level and separate kitchen house. However, the result reveals that Mirt stove adoption is negatively correlated with marital status (married), source of wood (getting wood without charge) and the price of the stove. These correlations between technology adoption and literacy level, marital status, having separate kitchen, source of wood and price support stacking and energy ladder theory in determining cookstove technologies adoption decision, respectively.

Table 4.17: Logistic Regression Estimation Result

Variables	Odds Ratio	P>|z|	Marginal effect(dy/dx)
age	1.028523	0.444	.0060471
age_sq	.999999	0.998	-2.13e-07
marstat	.1997575	0.006***	-.3800092
litlevel	17.04072	0.000***	.60974
famsize	1.093985	0.400	.019314
sepakich	9.236033	0.000***	.321457
sowood	.1456288	0.000***	-.4097594
price	.9646159	0.083*	-.007746
Statistics:			
Number of obs = 210		Prob > chi2 = 0.0000	
Wald chi2(8) = 73.27		Pseudo R2 = 0.3878	

Source: Own survey data (2014)

NB: ***** and ******* indicate the level of significance at 10 %, and 1 %, respectively.

According to this econometric result, in the study area marital status, literacy level, separate kitchen, source of fuel-wood and price significantly influence households' Mirt stove adoption decision. The other variables of age, age square and family size are no found to be significant in determining the likelihood of Mirt stove adoption decision. The above table shows the odds ratio of Mirt stove adoption, the p-value and the marginal effects of explanatory variables included in the binary logistic model.

4.2.2 Regression Result Interpretation

Variables that have significant explanatory power in determining the Mirt stove adoption decision are interpreted in this section. The odd ratio and the marginal effect of these powerful explanatory variables are interpreted.

Marital status: As Table 4.16 shows marital status significantly affects the probability of Mirt stove adoption with p-value and odd ratio of 0.006 and 0.1997, respectively. This odd ratio indicates that the probability of Mirt stove adoption is 0.1997 times higher for single

woman than a married woman. And also, the marginal effect of this variable is -0.3800 indicating that the probability of Mirt stove for married woman decreases by 38 percent as compared to single woman.

As it was expected, this finding reveals that single women were found more likely to adopt Mirt stove than married of their counterparts. This might be because of single women may have greater power in the household to make economic decisions (in this case the economic decision to purchase Mirt stove) than the married women. The result of this study is consistent with empirical studies of Adrianzen (2009) and Damte and Koch (2011) that found single women (female headed households) are more likely to adopt fuel efficient new technologies as compared to married women.

Literacy level: As it was expected, woman's level of literacy was found significant factor in that affect positively rural household's Mirt stove adoption decision with p-value of 0.000 and odd ratio of 17.0407. The odd ratio result indicates that the likelihood of adopting Mirt stove for literate woman is 17.04 times higher than illiterate woman. The marginal effect of this variable is 0.6097 implying that the probability of Mirt stove adoption for literate woman increases by 60.97 percent as compared to illiterate woman. This finding also confirms household energy stacking theory that asserts in addition to economic factors, there are other factors (for instance, literacy level) which affect a household's fuel and/or technology switching and/or adoption decision.

The finding of this study is similar to previous works (Puzzolo et al, 2013; Damte & Koch, 2011; Inayat, 2011; Tsangari, 2010) that found the higher education level of woman to be significant positive factor in determining a household's improved cookstoves adoption decision.

Separate kitchen: As Table 4.17 shows, as it was expected separate kitchen house was found positive significant factor that affects Mirt stove adoption decision with p-value of 0.000 and odd ratio of 9.2360, respectively. This odd ratio indicates that Mirt stove adoption probability for a household (woman) that has separate kitchen house is 9.23 times higher than a household (woman) that does not have separate kitchen house. The marginal effect is 0.3214 which indicates the probability of Mirt stove adoption for a household having

separate kitchen increases by 32.14 percent as compared to a household that has not separate kitchen. As it was discussed in descriptive analysis part, the fixed nature of Mirt stove is one reason for the need of separate kitchen to adopt it. The other explanation may be because of its larger in size, Mirt stove requires larger space. Since having separate kitchen house is one indicator of household wealth status (Damte & Koch, 2011), this finding of the study confirms energy ladder theory which asserts that a household's socio economic status determines technology adoption and fuel choice decision.

The finding of this study is in line with previous studies (Puzzolo, 2013; Axen, 2012; Damte & Koch, 2011; Adrianzen, 2009) that found separate kitchen house has significant positive effect on a household's improved cookstoves adoption decision. But, this study's finding is inconsistent with the work of Dawit (2008) that found the effect of separate kitchen house insignificant in determining the improved cookstoves adoption decision in rural areas. In Adea Woreda, Oromia Regional State, the proportion of rural households with separate kitchen lower than households without separate kitchen in adoption of Mirt stove. And the author justifies that rural households use their separate kitchen to store fuel wood instead of adopting Mirt stove. But, in Dembecha Woreda the proportion of rural households which have separate kitchen largely exceeds the proportion of households which have not separate kitchen house in adopting Mirt stove, as it was discussed in descriptive analysis section.

Source of wood: With p-value of 0.00 and odd ratio of 0.1456, a household's source of wood was found significant factor that affects households' Mirt stove adoption decision with marginal effect of -0.4097. The odd ratio of this variable shows that Mirt stove adoption probability for a household (woman) that gets fuel-wood with charge is 0.1456 times higher than a household (woman) that gets fuel-wood without charge. The marginal effect, also, indicates that the probability of Mirt stove adoption for a household (woman) that gets fuel-wood without charge decreases by 40.97 percent as compared to a household (woman) that gets fuel-wood with charge. As it was expected getting fuel-wood without charge was found negative factor that affects Mirt stove adoption decision while getting fuel-wood with charge was found positive factor that affects Mirt stove adoption decision.

This study is similar to previous works of (Geary et al, 2012; Inayat, 2011; Pine et al, 2011; Tsangari, 2010) that found access to open forest has significant negative effect on rural

households' improved cookstove new technologies. This study also came up with similar findings of Axen (2012) and Troncoso et al (2007) that found lack of free access for open forest is positively correlated with the adoption of improved cookstoves in rural households.

Price: As it was expected the price of Mirt stove was found to be a negative significant factor that determines a households' Mirt stove adoption decision. This variables has p-value, odd ratio and marginal effect of 0.083, 0.9646 and -0.0077, respectively. The odd ratio of 0.9646 for price shows that the probability of Mirt stove adoption decreases by 0.964 times for one birr increment in the price of Mirt stove. The marginal effect of -0.0077 for price, also, indicates that the probability of Mirt stove adoption decreases by 0.77 percent relatively as one birr increment in the price of Mirt stove. This finding confirms household energy ladder theory which asserts that a household's socio economic status (in here the ability to pay the price of Mirt stove) determines the adoption decision.

This study came up with similar findings of Puzzolo et al (2013), Gebreegziabher et al (2010) and Makame (2007) that found price as one determinant factor that affects improved cookstoves adoption decision. The result of the study also similar to the work of Slaski and Thurber (2009) that found high affordability of the price improved cookstoves as one factor that positively determines the adoption decision and the opposite also true.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

In this chapter the first section presents the conclusions based on the findings of the analysis and discussion part of the paper and following this, the recommendations are made based on the conclusions.

5.1 Conclusion

This study investigated factors affecting rural households Mirt stove adoption decision in Dembecha Woreda rural kebeles by taking 210 household respondents (women) systematically from the households frame. The study first assessed the gender-based responsibility, fuel type and energy consumption in households. The status and barriers of Mirt stove adoption in rural households were also assessed. For the purpose of investigating determinate factors of Mirt stove adoption decision, household respondents' characteristics of age, marital status, literacy level, family size, separate kitchen, source of fuel wood, price of Mirt stove, institutional and social factors were analyzed.

In the study area, females are the ones responsible for use and supply of fuel for household consumption. This implies that females are the victims of the adverse effects of preparing food and collecting fuel-wood as compared to male counterparts, in one hand and on the other hand, females are the primary beneficiaries of fuel efficient improved cooking technologies as compared to male household members. Concerning fuel type for household energy consumption, wood is the main source for cooking and of the cooking activities, baking Injera is the primary activity in terms of its energy requirement from fuel wood. Crop residuals, plant leaf and animal wastes also were found to be the other sources of energy. This heavily dependency of wood and crop residuals and leafs as sources of energy in rural areas may exacerbate, partly, deforestation and lose of soil fertility which in turn lead to environmental degradation and farm land productivity reduction.

In assessing status of Mirt stove adoption in study area, majority of households (63.3 %) were found to be non-adopters of Mirt stove. Perceived benefits of wood saving, cleaner cooking, safer to use and prompt cooking were found to be the main reasons to adopt Mirt stove. With the concern of awareness, though majority of majority of women were found to be aware of the adverse effects of baking Injera on open-fire like eye irritation and burn, majority of women were found unaware of the relative benefits of Mirt stove. In part, this may be attributed to low public awareness creation work that has been done by concerned bodies mainly Woreda Water Office (through Woreda rural energy experts), Woreda Agriculture Office (through kebele natural resource management experts) and Mirt stove producers since these nearby government agents and Mirt stove producers were found be more likely accessible sources of information for rural women. Social associations and media (mainly radio) were also indicated to be the other more accessible sources of information for rural mothers regarding new cookstove technologies. With regard to place, religious places, natural resource management works, meeting places and market places were found to be more accessible places for rural women to get information. Lack of awareness about its benefits, family members' reluctance, and higher price were found to be the most likely barriers of Mirt stove adoption. The problem of separate kitchen and shortage of supply were found to be the other most likely barriers of Mirt stove adoption in the study area.

The age and age square and family size were not found to be statistically significant to determine households' Mirt stove adoption decision. On the other hand, single women were found to be more Mirt stove adopter than the married counterparts. This implies that the probability of Mirt stove adoption for married woman decreases as compared to married woman. One plausible explanation for this may be because of single women has the full power to make economic decision in the household as compared to married ones. Married women may lack the power to make economic decisions in the household, since the husband is more powerful. In addition, literate women were found to be more Mirt stove adopter than the illiterates. This investigation indicates that the probability of Mirt stove adoption for literate woman increases as compared to illiterate woman. This may be resulted from that literate women are more likely to be aware about the benefits of improved cookstoves as compared to uneducated. These findings confirm energy stacking theory of technology choice.

This study investigated that those who have separate kitchen house are found to be more Mirt stove adopters as compared to those that have not. This reveals that probability of Mirt stove adoption for a household having separate kitchen increases as compared to a household that has not separate kitchen. The fixed nature of Mirt stove is one reason for the need of separate kitchen to adopt it. Its larger in size, which in turn requires larger space, may be another additional explanation for the need of separate kitchen to adopt Mirt stove. Since having separate kitchen house is one indicator of household wealth status this finding supports energy ladder theory with respect to households' cooking technology choice.

Those who get their fuel wood with charge are found to be more Mirt stove adopter as compared to those who get fuel-wood for free of charge. This finding implies that the probability of Mirt stove adoption for a household that gets fuel wood without charge decreases as compared to a household that gets fuel-wood with charge. This may be resulted from that wood saving may be the priority for households that get wood with charge while it is not the case for households that get fuel-wood for free.

Price was found to be statistically significant determinant factor of Mirt stove adoption decision. This study found that the probability of Mirt stove adoption decreases by one birr increment in the price of Mirt stove. This finding supports technology choice energy ladder theory.

The variable that decentralization of Mirt stove production sites reduces the cost and the probability of the stove to be broken was found be one of the most important institutional factors in influencing Mirt stove adoption decision. This may be due to Mirt stove's larger size and heavier weight to transport by users themselves: as a result, it may need other means of transportation that costs, in addition to its price. The other possible explanations might be problematic topography or unleveled road and long distance transportation. In rugged road regions or areas the probability of adoption of Mirt stove declines due to its fragility during transportation. Likewise, in long distance transportation the fragility of stove increases; as a result, the probability of adoption of Mirt stove decreases. Provision of different services and supports to the users and producers and denying open forest access were also found to be the other institutional factors that affect Mirt stove adoption decision. This may be, partly, because the role of institutions in creating an enabling working environment by providing

different services such as the access to credit and training and other material and technical supports to Mirt stove producers can influence the production of Mirt stove. In case of Mirt stove is highly available and in expanded public awareness about its benefits, the probability of adoption may be high.

From social factors, membership to local associations, active participation in social activities, early adopters' influence and neighbors' influence were also found to be important variables that affect Mirt stove adoption decision in the study. This may be because of being a member to and active in participation open and increase the opportunity to contact with individuals who have different information and experience and by these social organizations there will be information exchange can influence Mirt stove purchasing decision. In addition, the early Mirt stove adopters and neighbors may share their experience about the effect of adoption. These findings confirm energy stacking theory with regard to cooking technology choice.

5.2 Recommendation

For the success of disseminating initiatives, programs and projects and eventually for the realization of the potential health, economic and environmental benefits, understanding factors affecting improved cookstoves adoption decision offer various possible insights and policy implications. So that, based on the findings of this study the possible recommendation are forwarded below.

Based on the conclusion of the study, public awareness creation effort should be strengthened and targeted on religious places, natural resource management works, meeting places and market places through, for instance, rural energy experts, natural resource management experts and others. This study reveals that illiterate women are less likely to adopt Mirt stove than the literate women. This suggests that adult education in rural areas should be strengthened and continued.

Again, improved cookstoves disseminating initiatives, programs and/or projects should target on localities that purchase fuel-wood for the households' consumption. Likewise, in localities where fuel-wood is collected from local forests for free the government (for instance, through kebele natural resource management experts) should strengthen the work of local forest

protection and take appropriate measures on those who are arrested while collecting food from local forests.

Lack of awareness, which has been attributed to centralized rural energy experts assignment at Woreda level, was found to be the main barrier of Mirt stove adoption decision. It may be from this understanding that all of the key informants recommended for the need of more structural decentralization. Thus, there should be more structural decentralization in terms of assigning rural energy experts from Woreda to kebele level that is found to be nearer to the potential users for more public awareness creation and other related services. Shortage of Mirt stove supply was also indicated to be one barrier of adoption. So that, there should be considerable provision of different services such as the access to credit and training and supports to the producers and/or potential producers to increase availability of Mirt stove. Woreda agricultural office (through natural resource management experts), the Woreda water office (through rural energy experts) should provide stove accessories or basic hand tools such as spade, trowel, etc as well as specialized facility such as Mirt mould and wooden boards to the producers to the producers and/or potential producers.

All the members of the community should encourage and motivate women to become active participants in different social associations and activities. For instance, it may be possible by giving positions such as secretary, chair-person and/or coordinator to women in social associations like ‘Idir’, ‘Mahiber’ and other social ceremonies.

Further study: The researcher recommends further study to be conducted to investigate factors affecting Mirt stove adoption and sustained use in rural households.

References

Adkins, E., Tyler, E., Wang, J., Siriri, D. & Modi, V. (2010*). Field testing and survey evaluation of household biomass cook stoves in rural sub-saharan Africa. Energy for Sustainable Development 14 (2010) 172–185*

Adrianzén, M. (2009). *The role of social capital in the adoption of firewood efficient stoves in the Northern Peruvian Andes.* Working Paper Version – June 2009

Agarwal, B. (1983). *Diffusion of rural innovations: Some analytical issues and the case of wood-burning stoves. World Development, vol.11, No.4, PP.359-376*

Armendariz, C., Edwards, D., Johnson, M., Zuk, M., Rojas. L, Jiménez, D., Riojas-Rodriguez, H. & Masera, O. (2008). *Reduction in personal exposures to particulate matter and carbon monoxide as a result of the installation of a Patsari improved cook stove in Michoacan Mexico. Indoor Air 2008; 18(2):93-105*

Asres, WG. (2002). *Overview of Ethiopian energy status and trends in Ethiopia:* Paper Presented on Energy Conference 2002, Professional Association Joint Secretariat, UNICC, Addis Ababa, 21-22 March 2002

Assefa, Y. (2007). *Assessing environmental benefits of Mirt stoves with particular reference to indoor air pollution (carbon monoxide and suspended particulate matter) and energy conservation.* Unpublished Msc thesis, Addis Ababa University

Axén, J. (2012). *Fuel efficient and efficient aid: an analysis of factors affecting the spread of fuel efficient cooking stoves in Northern Tanzania.* Unpublished Thesis, Södertörn University

Barnes, D., Openshaw, K., Smith, K. & van der Plas, R. (1994) .*What makes people cook with improved biomass stoves? A comparative international review of stove programs. World Bank Technical Paper, Number 242*

Berkeley Air Monitoring Group (2012). *Stove performance inventory report*. Prepared for the Global Alliance for Clean Cookstoves United Nations Foundation, October 2012

Berrueta, V., Edwards, R. D & Masera, O. (2008) .*Energy performance of wood-burning cookstoves in Michoacan, Mexico. Renewable Energy 2007; 33 (5):859–70.*

Biomass Program (2011) .*Biomass cookstoves technical meeting: Summary Report.* January 11-12, 2011 Alexandria, VA

Biruk, B. (2011). *Factors influencing adoption of fuel efficient Injera baking stove*: *The case of Agarfa District, Oromia Region, Ethiopia*

Boone, H. & Boone, D. (2012). *Analyzing likert data*. *Jornal of extension Vol.50, Number 2* April 2012

Boy, E., Bruce, N. & Hernandaze, R. (2000*). Fuel efficiency of an improved wood-burning stove in rural Guatemala: Implications for health, environment and development. Energy for Sustainable Development, Volume IV, No. 2, PP.23-30, August 2000*

Bubendorfer, A. (2011). *Adoption of effective improved cookstoves in sub-Sahara Africa:* Case study in the Arua District. Unpublished thesis, KTH School of Industrial Engineering and Management

Bwenge, N. (2011).The effects of adopting improved wood stoves on the welfare of rural women: A case of Kibaha District in Tanzania. Unpublished Thesis Van Hall Larenstein University of Applied Sciences, Netherlands

César, E. & Ekbom, A. (2013) .*Ethiopia environmental and climate change policy brief.* Sida's helpdesk for environment and climate changes

Climate Institute (2009). *How does black carbon change the climate debate? Climate institute, Autumn 2009 Volume 19, No. 4*

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, CA: Sage.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches (15th ed)*. Los Angeles: Sage. Chicago

Damte, A. & Koch, S. (2011). *Clean fuel-saving technology adoption in urban Ethiopia.* Working paper 229

Dawit, G. (2011). *Energy demand in rural Ethiopia from a household perspective: A panel data analysis. The Journal of Energy and Development Volume 35, Number 2*

Dawit, W. (2008). *Fuel efficient technology adoption in Ethiopia: Evidence from improved "Mirt" stove technology: A Case in selected kebeles from "Adea" woreda. Ethiopian Journal of Economics, Volume Xvii, No 2, October 2008*

Dewan, A., Green,K., Li, X. & Hayden,D.(2013).*Using social marketing tools to increase fuel-efficient stove adoption for conservation of the golden snub-nosed monkey, Gansu Province, China. Conservation Evidence (2013) 32-36*

Duflo, E.,Greenstone,M. & Hanna,R.(2007*). Cooking stoves, indoor air pollution and respiratory health in rural Orissa, India*

Edwards, D., Smith, R., Zhang, J. & Ma, Y. (2004*). Implications of Changes in Household Stoves and Fuel Use in China. Energy Policy 32 (2004) 395–411*

Energy Sector Management Assistance Programme (1996). *Ethiopia energy assessment report. ESMAP, No. 179/96.* Washington, DC: World Bank.

Ergeneman, A. (2003). *Dissemination of improved cookstoves in rural areas of the developing world: Recommendations for the Eritrea dissemination of improved stoves program.* The Eritrea Energy Research and Training Center (ERTC)

Ethiopia Climate-Resilient Green Economy (2011*). Green economy strategy.* Federal Democratic Republic of Ethiopia

Fox, J. (2010) .*Logit and Probit Models: Notes. York SPIDA*

García-Frapolli, E., Schilmann, A., Berrueta,M., Riojas-Rodríguez, H., Edwards, D., Michael Johnson, M., Guevara-Sanginés, A., Armendariz, C. & Masera, O. (2010) .*Beyond fuelwood savings: Valuing the economic benefits of introducing improved biomass cookstoves in the Purépecha region of Mexico. Ecological Economics 69 (2010) 2598–2605*

Geary, C., Prabawanti, C. & Aristani, C. (2012) . *A field assessment of adoption of improved cookstove practices in Yogyakarta, Indonesia: Focus on structural drivers*

Gebreegziabher, Z., Cornelis van Kooten, G. & van Soest,.D (2006) . *Land degradation in Ethiopia: What do stoves have to do with it?* Presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12 -18, 2006

Gebreegziabher, Z., Mekonnen, A., Kassie, M. & Köhlin G. (2010) .*Urban energy transition and technology adoption: The case of Tigrai, Northern Ethiopia*. Discussion paper EfD 10(22). Environment for Development (EfD) Initiative, and Resources for the Future (RFF), Washington, DC

Gete, Z. & Hurni, H. (2001). Implications *of land use and land cover dynamics for mountain resource degradation in the northwestern Ethiopian highlands*. *Mountain Research and Development Vol 21 No 2 May 2001: 184–191*

Gifford, M. (2010*) .A global review of cookstove programs*

GIZ-HERA (2012). *Mirt stove:* Ethiopia. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH Postfach 5180 65726 Eschborn

GIZ (2013). *Clean and Efficient Cooking Energy for 100 Million Homes*: Results from the Bonn International Cooking Energy Forum 26–28 June 2013

Global Alliance for Clean Cookstoves (2012) .*Results report:* Sharing progress on the path to adoption of clean cooking solutions

Global Alliance for Clean Stoves (2011). *Igniting change*: A strategy for universal adoption of clean cookstoves and fuels

Grieshop, A., Marshall, D.J & Kandlikar, M. (2011). *Health and climate benefits of cookstove replacement options. Energy Policy 39(2011)7530-7542*

Gujarati, D. N. (2004). *Basic Econometrics* (4th ed.). New Work, NY: The McGraw−Hill Companies

Hosmer, W., Hosmer,T., Cessie, S. & Lemeshow1a, S.(1997). *Comparison of goodness-of-fit tests for the logistic regression model. Stat. in Med, Vol. 16, 965-980 (1997)*

Inayatullah, J. (2011) *What makes people adopt improved cookstoves? Empirical evidencefrom rural Northwest Pakistan.* The Governance of Clean Development, Working Paper Series 012 – January 2011

Inayatullah, J., Khan, H. & Hayat, S. (2012). *Determinants of household energy choices: An example from Pakistan. Pol.J.Environ.Stud.Vol.21, No.3 (2013), 635-641*

International Energy Agency (2010) .*Energy poverty: How to make modern energy access universal?* Special early excerpt of the World Energy Outlook 2010 for the UN General Assembly of the MDGs

Israel, G. (1992) .*Sampling the Evidence of extension program impact*. Program evaluation and organizational development, IFAS, University of Florida. PEOD-5. October

Jacob, N. (2013) .*Promotion and use of improved cookstoves in the conservation of biomass resources and biomass briquettes from solid wastes in the Gambia.* ISESCO Journal *of Science and Technology Vol. 9, No. 1 5, M a y 2 0 1 3 (1 7 - 2 6)*

Karekezi, S., Banda, K. & Kithyoma,W.(2002) .*Improving energy services for the poor in Africa – A gender perspective. ENERGIA News vol. 5 nr 4 • 2002*

Klasen, E., Miranda, J., Khatry, S., Menya, D., Gilman, R., Tielsch, J., Kennedy, C., Dreibelbis, R.., Naithani. N., Kimaiyo, S., Chiang,M., Carter, J., Sherman, C., Breysse, P., William Checkley, W. & COCINAS Trial Working Group (2013). *Feasibility intervention trial of two types of improved cookstoves in three resource-limited settings:* Study protocol for a randomized controlled trial. Trials 2013 14:327

Kowsari, R. (2013) .*Twisted energy ladder: Complexities and unintended consequences in the transition to modern energy services.* Unpublished PhD Dissertation, University of British Columbia

Lamarre-Vincent, J. (2011*)* .*What drives the adoption of stoves and improvements in respiratory health in Indonesia? Evidence from three waves of IFLS (1997, 2000, and 2007)*

Lee, C., Chandler, C., Lazarus, M. & Johnson, F. (2013) .*Assessing the climate impacts of cookstove projects:* Issues in emissions accounting. Stockholm Environment Institute, Working Paper 2013-01

Levine, D., Beltramo, T., Blalock, G. & Cotterman, C. (2013*)* .*What impedes efficient adoption of products?* Evidence from randomized variation in sales offers for improved cookstoves in Uganda

Lewis,.J & Pattanayak,S.(2012).Who *adopts improved fuels and cookstoves? A systematic review. Environmental Health Perspectives, volume 120, number 5, May 2012*

Livelihood Profile Amhara Region, Ethiopia (2007). Dembecha Woreda livelihood report.

Makame, O. (2007).*Adoption of improved stoves and deforestation in Zanzibar. Management of environmental quality: An International JournalVol. 18 No. 3, 2007 pp. 353-365.*

Makonese, T., Chikowore, G. & Annegarn, H. (2006). *The potential and prospects of improved cookstoves (ics) in Zimbabwe*

Masera, O., Saatkamp, D. & Kamme, M. (2000) .*From linear fuel switching to multiple cooking strategies: A critique and alternative to the energy ladder model. World Development Vol. 28, No. 12, Pp. 2083-2103, 2000*

Mekonnen, A. (2009). *Rural household biomass fuel production and consumption in Ethiopia: A case study. Journal of Forest Economics, vol. 5, no. 1 (2009), pp. 69-97*

Megen Power Ltd (2008) .*Impact assessment of mirt improved biomass injera stoves commercialization in Tigray, Amhara and Oromiya National Regional States: Report* submitted to the MoARD/GTZ SUN Energy Programme, March, 2008 Addis Ababa, Ethiopia

Menon, S. & Thandapani, S. (2011) .*Understanding the adoption dynamics of new products among people living in rural India* .Working paper (2011-2012), Centre for Development Finance, Institute for Financial Management Research

Ministry of Water and Energy (2012) .*Scaling - up renewable energy program Ethiopia investment plan final draft, January 2012.* Federal Democratic Republic of Ethiopia

Mobaraka, A., Dwivedib, P., Bailisb, R., Hildemannc, L. & Millerd, G. (2012). *Low demand for nontraditional cookstove technologies. PNAS July 3, 2012, vol. 109, no. 27, PP. 10815–10820*

Mousley,E., Kebede, D., Abreham, T. & Davey,G. (2013) .*The impact of podoconiosis on quality of life in Northern Ethiopia . Health and Quality of Life Outcomes 2013, 11:122*

National Clean Cookstoves Programme Ethiopia (NCCSPE, 2011). *Road map*

Onwuegbuzie, A. & Leech, L. (2004) .*Enhancing the interpretation of "significant" findings:* The role of mixed methods researc*h. The Qualitative Report* Volume 9 Number 4 December 2004 770-792

Pine, K., Edwards, R., Masera, O., Schilmann, A., Marrón-Mares, A. & Riojas-Rodríguez, H. (2011) . *Adoption and use of improved biomass stoves in Rural Mexico. Energy for Sustainable Development 15 (2011) 176–183*

Puzzolo, E., Stanistreet, D., Pope, D., Bruce, N. & Rehfuess, E. (2013). *Factors influencing the large-scale uptake by households of cleaner and more efficient household energy technologies: Systematic review*

Rehfuess, E. (2003). *Water & sanitation and household energy - Two critical determinants of children's health: WHO-AMG roundtable on "healthy environments for children" 21 October 2003. Protection of the Human Environment, World Health Organization*

Rogers, E.M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press

Romieu, I., Riojas-Rodríguez, H., Marrón-Mares, A., Schilmann, A., Perez-Padilla, R. & Masera, O. (2009) .*Improved biomass stove intervention in rural Mexico: Impact on the respiratory health of women. American Journal of Respiratory and Critical Care Medicine 180, 649–656.*

Rwiza, M. (2009) .*Innovations and sustainability: The case of improved biomass stoves adoption and use in Tanzania.* Unpublished maters thesis, Lund University, Sweden

Schlag, N. and Zuzarte,F. (2008). *Market barriers to clean cooking fuels in sub-saharan Africa: A review of literature.* Working paper, Stockholm Environment Institute, April 2008

Shanko, M. (2001). *Ethiopia's experience. Minutes of the dissemination and strategy seminar on poverty reduction aspects of successful improved household stoves program (DFID Kar project7368).* Grand Imperial hotel, kampala, Uganda, Friday 29th June, 2001

Simons, L. (2012). *Reducing Ethiopian household fuel use with 80%: Report second visit Sunny Simons Ethiopia*

Slaski, X. & Thurber, M. (2009). *Research note: Cookstoves and obstacles to technology adoption by the poor.* Program on energy and sustainable development working paper No. 89 Stanford, CA

Smith, K. & Deng, K. (2010) *A Chinese national improved stove program for the 21st century to promote rural social and economic development.* English translation of article in Chinese in *Energy Policy Research*, 2010.1, 24-25.

Stock, J. & Watson, M. (2007).*Introduction to econometrics* (2nd ed.). Botson: Pearson Addison Wesley

Takama, T., Lambe,F., Johnson, X., Arvidson, A., Atanassov,B., Milkyas,. , Nilsson,L., Tella,P. & Tsephel, S. (2011) .*Will African consumers buy cleaner fuels and stoves? A household energy economic analysis model for the market introduction of bio-ethanol cooking stoves in Ethiopia, Tanzania and Mozambique: Research report, Stockholm Environment Institute, 2011*

Taylor, B., Sinha, G. & Ghoshal, T. (2011). *Research Methodology*: A guide for researchers in management and social sciences. PHI Learning Private Limited. New Delhi-110001

Teodoro, S. (2008) *Lessons from project implementation on cook stoves and rural electrification, the practical action experience*

Troncoso, K., Castillo, A., Masera, O. & Merino, L. (2007). *Social perceptions about a technological innovation for fuelwood cooking: Case study in rural Mexico. Energy Policy 35, 2799–2810*

Tsangari, M., P. (2010). *Challenges facing wide-scale adoption of improved cook stoves in rural Kenya:* a case of Wundanyi, Mwatate and Voi Districts

Winrock International (2011). *The Kenyan household cookstove sector:* Current state and future opportunities

Wooldridge, J. (2009). *Introductory econometrics*: A modern approach (4th ed.). South-Western Cengage Learning: Macmillan Publishing Solutions

Water Office (2013). *Energy sources and expansion*: Semi-annual report. Dembecha Woreda

World Food Program-Ethiopia (2013) .*Component project design document form for small-scale component project activities (F-CDM-SSC-CPA-DD).* Ethiopia improved cookstoves initiative programme of activities. Generic component project activity (CPA) for Mirt and Tikikil stoves

World Health Organization (2009) .*Guidelines for indoor air quality: Dampness and mould.* WHO Regional Office for Europe, Copenhagen, Denmark

Wosenu, A. (2004).*Guideline for improved stoves site selection and dissemination.* Ethiopian rural energy development and promotion center, ministry of rural development

Yared, A. & Mesgebu, T. (2010). Angot-yedgera Alekitam kebele watershed study document. March2010, Dembecha Woreda, Amhara Regional State.

Zou, J. (2006). Elements of statistics: Lecture note. AMS 102.7 Spring 2006

Appendices

Appendix A: Logistic Model (Goodness-of-Fit Test)

```
. estat gof

Logistic model for msa, goodness-of-fit test

       number of observations =       210
 number of covariate patterns =       202
           Pearson chi2(193) =       183.26
                 Prob > chi2 =         0.6809
```

Appendix B: Pair-wise Correlations Coefficient and VIF Tests

```
. pwcorr age age_sq marstat litlevel famsize sepakich wosource price

             |      age   age_sq  marstat litlevel  famsize sepakich wosource price
-------------+------------------------------------------------------------------------
         age |   1.0000
      age_sq |   0.6084   1.0000
     marstat |   0.0504  -0.0843   1.0000
    litlevel |  -0.4467  -0.1786   0.1081   1.0000
     famsize |   0.4032   0.1836   0.1136  -0.1932   1.0000
    sepakich |   0.2666   0.2258   0.1528   0.1734   0.1473   1.0000
    wosource |   0.3738   0.2137   0.1957  -0.4082   0.1728   0.1606   1.0000
       price |   0.1742   0.1064  -0.0673  -0.1052  -0.0107  -0.0450   0.2003 1.0000
-------------------------------------------------------------------------------------

. vif

    Variable |       VIF       1/VIF
-------------+----------------------
         age |      2.48    0.403208
    litlevel |      1.69    0.593039
      age_sq |      1.68    0.594588
    wosource |      1.45    0.692005
    sepakich |      1.29    0.777455
     famsize |      1.22    0.816905
     marstat |      1.15    0.868058
       price |      1.09    0.917218
-------------+----------------------
    Mean VIF |      1.51
```

Appendix C: linktest, ovtest, hettest Tests and Scale Reliability Test

```
Logistic regression                                     Number of obs   =        210
                                                        LR chi2(2)      =     107.15
                                                        Prob > chi2     =     0.0000
Log likelihood = -84.425763                             Pseudo R2       =     0.3882

------------------------------------------------------------------------------
         msa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        _hat |   .9900722   .1310976     7.55   0.000     .7331256    1.247019
      _hatsq |  -.0261161   .0764244    -0.34   0.733    -.1759052     .123673
       _cons |   .0603052   .2715224     0.22   0.824    -.4718689    .5924793
------------------------------------------------------------------------------

. ovtest

Ramsey RESET test using powers of the fitted values of msa
       Ho:  model has no omitted variables
                 F(3, 198) =      1.52
                  Prob > F =      0.2104


. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of msa

         chi2(1)      =     1.20
         Prob > chi2  =   0.2740
```

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	210	100.0
	Excluded[a]	0	.0
	Total	210	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.842	40

Appendix D: Logistic Regression Estimation Result

```
. logistic msa age age_sq marstat litlevel famsize sepakich wosource price,robust

Logistic regression                                     Number of obs   =        210
                                                        Wald chi2(8)    =      73.27
                                                        Prob > chi2     =     0.0000
Log pseudolikelihood = -84.484118                       Pseudo R2       =     0.3878

------------------------------------------------------------------------------
             |               Robust
         msa | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |   1.028523   .0377482     0.77   0.444     .9571365    1.105235
      age_sq |    .999999   .0003512    -0.00   0.998     .9993109    1.000688
     marstat |   .1997575   .1178239    -2.73   0.006     .0628688    .6347041
    litlevel |   17.04072   11.23039     4.30   0.000     4.682935    62.00939
     famsize |   1.093985   .1167792     0.84   0.400     .8874589    1.348572
    sepakich |   9.236033   5.664322     3.62   0.000     2.776235    30.72662
    wosource |   .1456288   .0605682    -4.63   0.000     .0644504    .3290554
       price |   .9646159   .0200756    -1.73   0.083     .9260602    1.004777
       _cons |   13.13012   38.73961     0.87   0.383     .0404437     4262.72
------------------------------------------------------------------------------

. mfx

Marginal effects after logistic
      y  = Pr(msa) (predict)
         =  .31295578
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.      z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
     age |   .0060471      .00781    0.77   0.439   -.00926  .021354   39.6429
  age_sq |  -2.13e-07      .00008   -0.00   0.998  -.000148  .000148   1517.34
 marstat*|  -.3800092      .13069   -2.91   0.004  -.636155 -.123863   .885714
litlevel*|     .60974      .10162    6.00   0.000    .41057   .80891   .204762
 famsize |    .019314      .02304    0.84   0.402   .025836  .064464   5.10952
sepakich*|    .321457      .06017    5.34   0.000   .203518  .439396   .857143
wosource*|  -.4097594      .08205   -4.99   0.000  -.570576 -.248943   .561905
   price |   -.007746      .00447   -1.73   0.083  -.016503  .001011    136.31
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```

Appendix E: Questionnaire, Questions for Interviews and Focus Groups Discussion

Mekelle University

College of Business and Economics

Department of Management

A. Questionnaire filled by women

Objective:

Dear respondents, the purpose of this questionnaire is to gather primary data about factors affecting adoption of 'Mirt' Injera baking stove. The study is for partial fulfillment of the requirements for Masters Degree in Development Studies at Mekelle University. I confirm you that all data will be used for academic purpose and your responses will be kept confidential.

Instructions:

- No need of writing name
- Where boxes are available please tick (√) in the box.
- Where boxes are unavailable write the letter(s) and/or answers on the spaces provided.

Thank you for your cooperation!!!

Part I: Household Characteristics

1. Age_____(in years)
2. Marital Status:

   Married ☐ Single ☐
3. Literacy level:

   Illiterate (cannot read and write) ☐

   Literate (can read and write) ☐
4. Total family size:_____ (in number)
5. Do you have separate kitchen house?

   Yes ☐ No ☐
6. Who is/are more responsible to fulfill cooking appliances in your family?

   Females ☐ Males ☐
7. Who is/are more responsible to prepare food in your family?

   Females (mainly the mother and/or daughters) ☐

   Males ☐
8. Who is/are more the responsible for fuel wood supply in your family?

   Females ☐ Males ☐

   Children ☐ Males and Females ☐
9. Who is/are more responsible to bake Injera in your family?

   Females ☐ Males ☐

Part II: Questions about source of fuel wood

10. Which type of fuel is the main source of energy for cooking and heating for the family?

    Wood ☐ Animal waste ☐

    Crop residuals & Plant leaves ☐ Charcoal ☐ Kerosene ☐
11. Which cooking practice consumes the largest household's energy supply?

    Injera baking ☐ Water heating and other ☐

    House heating and lightening ☐
12. Which one is the main source of energy for injera baking?

    Wood ☐ Animal waste ☐

    Crop residuals ☐ Charcoal ☐ Plant leaves ☐

13. Is fuel wood available for free of charge for your family energy consumption?

Yes ☐ No ☐

Part III: Mirt stove adoption and other related issues

14. Do you have information about the health, economic and environmental benefits of using 'Mirt' stove?

Yes ☐ No ☐

15. Are you aware of the adverse effects of Injera baking on Sost-gulcha?

Yes, such as eye irritation and burn ☐ No ☐

16. _____Which source of information do you think that the most likely accessible, as compared to others, for the rural households regarding to 'Mirt' stove? Choose one.

a. government bodies such as agricultural experts and health extension workers
b. media like radio
c. Mirt stove producers
d. social associations, neighbors
e. others

17. _____Which place do you think is the most accessible, as compared to others, to users (mainly mothers) to be informed about new technologies?

a. Religious places (church, mosque)
b. Natural resource management works (e.g. during terracing works)
c. Market places
d. During meetings (e.g. formal, informal meetings)
e. others

18. _____Did you purchase 'Mirt' stove?

Yes ☐ No ☐

If you did purchase Mirt stove, please state your opinion for each given reason to purchase by using 1= strongly disagree 2= disagree 3= neutral 4= agree 5= strongly agree

	Reasons	1	2	3	4	5
19	Mirt stove saves fuelwood					
20	Mirt stove is cleaner					
21	Mirt stove is convenient to use					
22	Mirt is quicker					
Separate kitchen room and adoption						
23	Having separate kitchen room influences on 'Mirt' stove purchasing decision					
24	The fixed nature of Mirt stove is one reason to have a separate kitchen.					

Part III: Price of Mirt stove and opinion

25. What is the price of Mirt stove in your locality?_____(in birr)

26. _____What would you say about its cost?

Cheap ☐ Fair ☐ Expensive ☐

Part V: Institutional factors

Please state your opinion for each given statement using the following scales: 1= strongly disagree 2= disagree 3= neutral 4= agree 5= strongly agree

	Items	1	2	3	4	5
27	The nearby government institutions (through development agents, experts, health extensions) can influence Mirt stove purchasing decision					
28	Institutionally deny the access to forest can influence Mirt stove using decision					
29	By providing services (e.g. awareness creation,					

	quality control, price regulation) government institutions can affect rural households' Mirt stove adoption decision					
30	By providing supports (e.g. material, technical, financial) institutions can affect the production and adoption of 'Mirt' stove.					
31	Institutions can influence the availability and accessibility of Mirt stove by decentralizing its production site.					
32	Decentralizing production site to users can affect Mirt stove purchasing decision by reducing the probability of Mirt stove to be broken during transportation					
33	Decentralizing Mirt stove production site to users can affect Mirt stove purchasing decision by reducing its cost such as transportation cost.					

Part VI: Social factors

34. Are you member of different social organizations in your locality, at least three and above?

Yes ☐ No ☐

35. Are you active participant in local associations and activities? Chairman, secretary and/or coordinator.

Yes ☐ No ☐

Please state your opinion for each given statement using the following scales: 1= strongly disagree 2= disagree 3= neutral 4= agree 5= strongly agree

	Items	1	2	3	4	5
36	Membership to different social organizations in the community can influence Mirt stove					

	purchasing decision.					
37	By social organizations there will be information exchange that can affect Mirt stove purchasing decision.					
38	Earlier adopter of Mirt' stove can influence the others Mirt stove adoption decision by speaking what is the reality of using it.					
39	Neighbors have influence on the others Mirt stove adoption decision.					

Part VII: Barriers from the respondents' point of view

40. _____Which number contains the first four most likely barriers to purchase Mirt stove in your locality, from your point of view?

a. lack of awareness about 'Mirt' stove's benefits
b. family reluctance (e.g. spouse's lack of willingness)
c. higher price of the stove
d. problem of separate kitchen house
e. Shortage of Mirt stove supply

1. a, b, c & d 2. b, c, d & e 3. a, c, d & e

መቐለ ዩኒቨርሲቲ

ቢዝነስ እና ኢኮኖሚክስ ኮሌጅ

ማኔጅመንት ትምህርት ክፍል

በሴቶች ብቻ የተሞላ መጠይቅ

ዓላማ፡-

ዉድ መልስ ሰጭዎች፣ የዚህ መጠይቅ አላማ በ‘ምርጥ’ የእንጀራ ማስፊያ ምድጃ ‘ለመገልገል’ ተፅኖ ስለሚያደርጉ ነገሮች የመጀመሪያ ደረጃ ጭብት ለመሰብሰብ ነዉ፡፡ ይህ ጥናት በመቐለ ዩኒቨርሲቲ በ ‘ዴቨሎፕመንት ስተዲስ’ የማስተርስ ዲግሪ የሚስፈልጉ ነገሮች ለከፊል ማሙያነት ነዉ፡፡ ሁሉም ጭበጥ ለትምህርት ዓላማ እንደምጠቀምባቸዉ እና መልሶቻችሁ በምስጢር እንደሚጠበቁ አረጋግጣለሁ፡፡

ትዕዛዛት፡-

- ስም መፃፍ አያስፈልግም
- ሳጥኖች ካሉ እባክዎን ከሳጥኑ ዉስጥ (√) ያድርጉ
- ሳጥኖች ከሌሉ፣ ፊደሉን (ሎችን) እና/ወይም መልሱን በተስጠዉ ክፍት ቦታ ላይ ይፃፉ

ስለትብብራችሁ አመሰግናለሁ!!!

ክፍል አንድ፡-የቤተሰቡ መገለጫዎች

1. የዕድሜ ፤----------(በቁጥር)
2. የ ጋብቻ ሁኔ ታ፤

   ያገ ባች ☐ ያላገ ባች ☐
3. የ ማን በብና መፃ ፍ ደረ ጃ፤

   ማን በ ብና መፃ ፍ የሚች ል ☐ ማን በ ብና መፃ ፍ የማይች ል☐
4. ጠቅላ ላ የ ቤተሰ ብ ቁጥር ----------
5. ለ ብቻዉ የ ተለ የ ኩሽና ቤት አ ለ ዎት?

   አ ዎ ☐ የ ለ ም ☐
6. ከ ቤተሰ ብዎ በ ይበ ልጥ የ ምግብ ማብሰ ያ እ ቃዎችን የ ማመላ ት ሀ ላፊ ነ ት ያ ለዉ ማን ነ ዉ/እ ነ ማን ና ቸዉ?

   ሴ ቶች ☐ ወን ዶች ☐
7. ከ ቤተሰ ብዎ በ ይበ ልጥ ምግብ የ ማዘ ጋጀ ት ሀ ላፊ ነ ት ያ ለዉ ማን ነ ዉ/እ ነ ማን ና ቸዉ?

   ሴ ቶች (በ ዋነ ኛ ነ ት እ ና ቶች) ☐ ወን ዶች ☐
8. ከ ቤተሰ ብዎ በ ይበ ልጥ የ ማገ ዶ እ ጨት የ ማቅረ ብ ሀ ላፊ ነ ት ያ ለዉ ማን ነ ዉ/እ ነ ማን ና ቸዉ?

   ሴ ቶች ☐ ህፃ ና ት☐

   ወን ዶች ☐ ሴ ቶችና ወን ዶች☐
9. ከ ቤተሰ ብዎ በ ይበ ልጥ እ ንጀ ራ ማስ ፋት ሀ ላፊ ነ ት ያ ለዉ ማን ነ ዉ/እ ነ ማን ና ቸዉ?

   ሴ ቶች ☐ ወን ዶች ☐

ክ ፍል ሁለ ት፡ - የ ማገ ዶ እ ጨት ምን ጭ

10. ለ ቤተሰ ቡ ዋነ ኛ ለ ምግብ ማብሰ ያ እ ና ለ መቀ ት የ ሀ ይል ምን ጭየ ትኛ ው?

    እ ን ጨት☐ የ እ ን ስሳ ት ፅ ዳጅ ☐

    የ ሰ ብል ገ ለ ባ እ ና ዕ ፅ ዋ ት ቅ ጠላ ቅ ጠሎች☐ ከ ሰ ል☐ ጭ ጋ ዝ☐
11. የ ቤተሰ ቡን ብዙ ዉን የ ሀ ይል አ ቅ ር ቦ ት የ ሚጠ ቀ መዉ ምግ ብ የ ማብሰ ል ተግ ባ ር የ ትኛ ው ነ ዉ?

    እ ን ጀራ ማስ ፋ ት☐ ዉኃ ማሞቅ ና ሌሎች☐

    ቤት ማሞቅ ያ ና ለ ብር ሃ ን ነ ት ☐
12. ለ እ ን ጀራ ማስ ፍያ ነ ት የ ሚዉል ዋነ ኛ የ ሀ ይል ምን ጭየ ትኛ ውነ ዉ?

    እ ን ጨት☐ የ እ ን ስሳ ት ፅ ዳጅ ☐

    የ ሰ ብል ገ ለ ባ☐ ከ ሰ ል ☐ ዕ ፅ ዋ ት ቅ ጠላ ቅ ጠሎች ☐

13. ለቤተሰቡየማገዶእጨትዋናምንጭየትኛውነዉ?

ምንምገንዘብየማያስወጣ (ምሳሌ፤ በአካባቢከሚገኙደኖች መልቀም፣ ካሳደግነዉዛፍ) ☐

በገንዘብ (እጨት በመግዛት) ☐

ክፍልሶስት፡-ምርጥምድጃን መላልገልእናተያያዝጉዳዮች

14. ስለምርጥማገዶቆጣቢምድጃየጤና፣ ኢኮኖሚዊና አካባቢያዊጥቅሞች መረጃአለዎት?

አዎ ☐ የለም ☐

15. በሶስትጉልቻላይእጀራማስፋትስላለዉጎጅዉጤቶችእዉቅናአለዎት?

አዎ ☐ የለም ☐

16. _____ከሌሎች ጋር ሲነፃፀር ለገጠር ሴቶች ስለምርጥ ምድጃ ተሻለ ተደራሽ የመረጃ ምንጭ የትኛዉነዉ ብለዉያስባሉ?አንድይምረጡ:

ሀ. የመንግስት አካላት እንደ ግብርና ባለሙዎች፣ የጤና ኤክስቴንሽኖች

ለ. መገናኛ እንደ ሬድዬ

ሐ. የምርጥ ምድጃ አምራቾች

መ. ማህበራዊ ማህበራት፣ ጎረቤት

ሠ. ሌሎች

17. _____ከሌሎች ጋር ሲነፃፀር ለተጠቃሚዎች (በዋነኛነት እናቶች) የስለአዳዲስ ቴክኖሎጅዎች መረጃ ለማግኘት የተሻለ ተደራሽ ቦታ የትኛዉነዉ ብለዉያስባሉ?አንድይምረጡ:

ሀ. የአምልኮት ቦትዎች (ቤተ-ክርስቲያን፣ መስጊድ)

ለ. የተፈጥሮ ሀብተ አያያዝ ስራዎች (ምሳሌ፣ በዕርከን ስራዎች)

ሐ. ገበያ ቦታዎች

መ. በስብሰባዎች ጊዜ (ምሳሌ፣ መደበኛና መደበኛ ያልሆኑ ስብሰባዎች)

ሠ. ሌሎች

18. ምርጥምድጃንገዝተዋል?

አዎ ☐ የለም ☐

ምርጥምድጃንከገዙእባክዎን የሚከተሉትን መመዘናዎች በመጠቀም ለእያንዳንዱ የተሰጠ ለመግዛት ምክንያት ሀሳብዎን ይስጡ ፡ 1-በጣም አልስማማም፣ 2-አልስማማም፣ 3-ግሉል፣ 4- እስማማለሁ ዎይም በጣም አልስማማም

ተ.ቁ	ምክንያት	1	2	3	4	5
19	ምርጥ ምድጃ እንጨት ይቆጥባል					
20	ምርጥ ምድጃ ንፁህ ነዉ					
21	ምርጥ ምድጃ ሲጠቀሙት ምቹ ነዉ					
22	ምርጥ ምድጃ ፈጣን ነዉ					
ኩሽና ቤተና ምርጥ ምድጃን መጠልግል						
23	የብቻ ኩሽና ቤት መኖር ምርጥ ምድጃን በመጣት ወሳኔ ላይ ተፅኖ አለዉ					
24	የምርጥ ምድጃ ቻሚ የመሆን ተፈጥሮ የብቻ ኩሽና እንዲኖር አንድ ምክንያት ነዉ					

ክፍል አራት፡ -የምርጥ ምድጃ ዋጋና አስተያት

25. የምርጥ ምድጃ ዋጋ ስንት ንዉ?---------. (በብር)

26. ስለዋጋዉ ምን ይላሉ?

ርካሽ ☐ ተመጣጣኝ ☐ ዉድ ☐

ክፍል አምስት፡ - ተቻማዊ ነገሮች

እባክዎን የሚከተሉትን መመዘናዎች በመጠቀም ለእያንዳንዱ የተሰጠ መልጫ ሀሳብዎን ይስጡ ፡ 1 -በጣም አልስማማም፣ 2-አልስማማም፣ 3-ግሉል፣ 4- እስማማለሁ ዎይም በጣም አልስማማም

ተ.ቁ	ተቻማዊ ነገሮች	1	2	3	4	5
27	በአቅራቢያ የሚገኙ መንግስት ተቻማት (በግብርና ባለሙያዎች፣ በጤና ኤክስቴንሽን ሰራተኖች በኩል) ምረጥ ምድጃን በመጣት ወሳኔ ላይ ተፅኖ ማድረግ ይችላሉ					
28	በክፍት ደን ተደራሽነት ላይ ተቻማዊ ክልከላ ማድረግ ምረጥ ምድጃን በመጠልገል ወሳኔ ላይ ተፅኖ ማድረግ ይችላል					

29	አገልግሎቶችን በማቅረብ (ምሳሌ፣ እውቅና መፍጠር፣ ጥራትንና ዋጋን መቆጣጠር) የገጠር አባወራዎች ምረጥ ምድጃን በመገልገል ዉሳኔ ላይ ተፅኖ ማድረግ ይቻላል					
30	ድጋፎችን በማቅረብ (ምሳሌ፣ ቁሳዊ፣ በገንዘብ፣ ቴኪኒካል) ምረጥ ምድጃን በማምረትና በመገልገል ዉሳኔ ላይ ተፅኖ ማድረግ ይቻላል					
31	ተቻማት የማምረቻ ቦታን ያልተማከለ በማድረግ የምረጥ ምድጃ መገኘትና ተደራሽነት ላይ ተፅኖ ማድረግ ይቻላል					
32	በትራንስፖርት ገዜ የመሰበር አጋጣሚዉን ስለሚቀንስዉ፣ የማምረቻ ቦታን ወደተጠቃሚዎች ያልተማከለ ማድረግ ምረጥ ምድጃን በመግዛት ዉሳኔ ላይ ተፅኖ ማድረግ ይቻላል					
33	ዋጋ ስለሚቀንስ፣ እንደ የትራንስፖርት ዋጋ፤ የማምረቻ ቦታን ወደተጠቃሚዎች ያልተማከለ ማድረግ ምረጥ ምድጃን በመግዛት ዉሳኔ ላይ ተፅኖ ማድረግ ይቻላል					

ክፍል ስድስት፡ -ማህበራዊ ነገሮች

34. በሚኖሩበት አካባቢ የተለያዩ ማህበራዊ ድርጅቶች አባል ነዎት፣ ቢያንስ ሶስትና ከዚያ በላይ?

አዎ ☐ የለም ☐

35. በማህበራዊ ድርጅቶች እና ተግባራት ንቁ ተሳታፊ ነዎት? (በሊቀ-መንበርነት፣ ፀሀፊነት፣ እና / ወይም አስተባባሪነት)

አዎ ☐ የለም ☐

እባክዎን የሚከተሉትን መመዘናዎች በመጠቀም ለእያንዳንዱ የተሰጠ መግለጫ ሀሳብዎን ይስጡ ፡ 1 -በጣም አልስማማም፣ 2-አልስማማም፣ 3-ግሉል፣ 4- እስማማለሁ ዎይም በጣም አልስማማም

ተ.ቁ.	ማህበራዊ ነገሮች	1	2	3	4	5
36	በማህበረሰቡ ዉስጥ ለተለያዩ ማህበራዊ ድርጅቶች አባል መሆን ምረጥ ምድጃን በመግዛት ወሳኔ ላይ ተፅኖ ማድረግ ይችላል.					
37	በማህበራዊ ድርጅቶች የሚኖረዉየ መረጃ ልዉዉጥ ምረጥ ምድጃን በመግዛት ወሳኔ ላይ ተፅኖ ማድረግ ይችላል.					
38	ምርጥ ምድጃ መጠቀም ያለዉን እዉነታ በመገር፣ ቀድምት ተገልጋዮች በሌሎች ምረጥ ምድጃን በመግዛት ዉሳኔ ላይ ተፅኖ ማድረግ ይችላሉ					
39	ጎረቤቶች የሌሎችን ምረጥ ምድጃን የመግዛት ወሳኔን ተፅኖ ማድረግ ይችላሉ					

ክፍል ሰባት፡ -መረጥ ምድጃን ለመገልገል መሰናክሎች

40._____በሚኖሩበት አካባቢ ምርጥ ምድጃን ለመግዛት አራቱን የመጀመሪያ ሊሆኑ የሚችሉ መሰናክሎችን የያዘዉቁትር ትኛዉነዉ?

ሀ. ስለ ምርጥ ምድጃ ጥቅሞች ዕዉቅና ማነስ

ለ .የ ቤተሰብ ፈቃደኛ አለመሆን (ምሳሌ፡ -የ ባላ ቤተዎ የ ፈካደኝነት ማነስ)

ሐ. የ ምድጃዉዋጋ ከፍተኛ መሆን መ. ኩሽ ቤት ያለመኖር ችግር ሠ .የ ምድጃዉ የ አቅርቦት ማነስ

1. ሀ፣ ለ ፣ ሐ እና መ 2. ለ፣ ሐ፣ መ እና ሠ 3. ሀ ፣ ሐ፣ መ እና ሠ

B. Guiding questions for interviews with key informants of Woreda agricultural office, Woreda water office (specifically rural energy experts) and kebele agricultural agents

1. Does your office provide services and supports to potential users and producers of Mirt stove? If so, what are they?
2. What financing options are available to potential users and local Mirt stove producers?
3. In your experience, how widely is 'Mirt' stove available?
4. In your experience, what are the most likely barriers of 'Mirt' stove adoption?

C. Guiding questions for interview with 'Mirt' stove producers

1. Does the concerned body provide supports like technical, financial, materials such as the inputs of production and training?
2. What problem(s) you are facing to produce 'Mirt' stove?
3. It may be from your experience, the information you do have, what do you think that barriers for the purchasing of 'Mirt' stove?
4. Do you think that the distance from 'Mirt' stove production site to potential users has influence on households 'Mirt' stove adoption decision?
5. Do you have information from the potential users that the price (end user cost) of the stove has its influence on households' decision to buy 'Mirt' stove?

D. Guiding questions for FGDs in the presence of Woreda agricultural office, Woreda water office (specifically rural energy experts), kebele natural resource management experts and 'Mirt' stove producers

1. Do you think that the public is fully aware about the advantages of adopting 'Mirt' stove?
2. Do the concerned bodies provides supports like technical, financial, materials, training and awareness to the local 'Mirt' stove producers and potential users?
3. It may be from your experience, the information you do have, what do you think that barriers for the purchasing of 'Mirt' stove?
4. Do you have information from the potential users that the price of the stove has its influence on households' decision to buy 'Mirt' stove?
5. Do you think that distance from 'Mirt' stove production site to potential users has influence on households 'Mirt' stove adoption decision?